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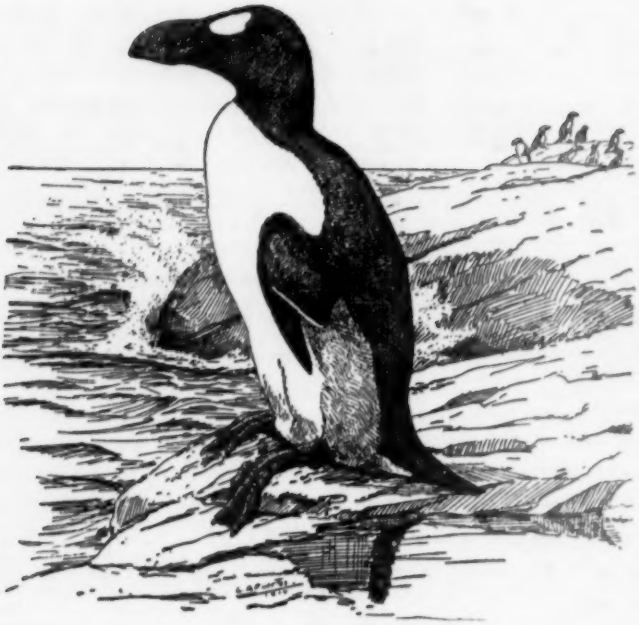

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COMPARATIVE FORAGING BEHAVIOR OF THE SPOTTED AND BROWN TOWHEES

BY JOHN DAVIS

THE Spotted and Brown towhees (*Pipilo erythrophthalmus* and *P. fuscus*) are common and widespread species in western North America. Both are mainly terrestrial, have similar body proportions, and are at present considered congeneric. In spite of their ready availability as objects for study, their foraging behavior has only been described in very general terms. Aside from Woodbury's brief paper (1933: 70) on foraging by scratching in the Spotted Towhee, and the suggestions of food preferences as indicated by Beal's extensive analyses of the stomach contents of the Spotted and Brown towhees (1910: 86–93), little attention has been paid to their foraging behavior. In this study both species were observed throughout the year in an effort to determine whether differences existed in their foraging behavior, and their hind limb osteology and myology were examined to see whether differences in foraging methods were reflected by differences in internal morphology. The particular subspecies of towhees with which this study is concerned are *Pipilo erythrophthalmus megalonyx* and *Pipilo fuscus crissalis*. Northern Monterey County marks the northern limits of distribution for both forms. Throughout this paper the term "Spotted Towhee" refers to the western races of the Red-eyed Towhee (*Pipilo erythrophthalmus*).

Vernacular and scientific names of plants are from Linsdale (1955).

ACKNOWLEDGEMENTS

Dr. William H. Behle and Dr. Allan R. Phillips kindly supplied body weights of *Pipilo erythrophthalmus montanus* collected in Utah and Arizona, respectively. I wish to thank the following persons for permission to collect on their ranches: Levi S. Cahoon, William G. Lambert, Agnes Melin, Al Stopp, and John H. Tregea. Facilities and support made available through the generosity of Mrs. Russell

P. Hastings have contributed materially to the completion of this study.

MATERIALS

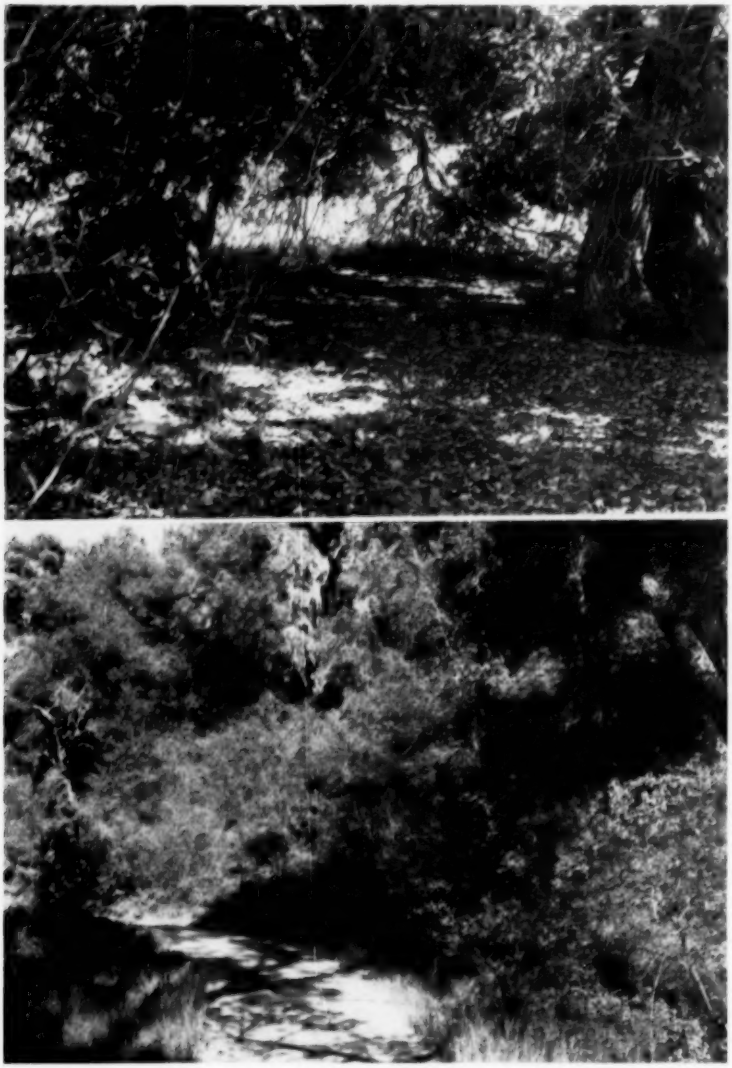
Most of the material presented is taken from my field notes, written between August 7, 1953, and February 29, 1956, at the Hastings Reservation, two and one-half miles east of Jamesburg, northern Monterey County, California. For a detailed description of this locality see Linsdale (1943: 256–260). In addition, field notes recorded by the following workers at the Hastings Reservation were used: Dana Abell, Lowell Adams, Walter W. Dalquest, Floyd E. Durham, Robert B. Finley, Jr., Henry S. Fitch, John A. Gray, Jr., Henry A. Hjersman, Robert Holdenried, Douglass H. Hubbard, Carl B. Koford, Enid A. Larson, Donald D. Linsdale, Jean M. Linsdale, Joe T. Marshall, Jr., Thane A. Riney, Charles G. Sibley, Lloyd P. Tevis, Jr., P. Quentin Tomich, Howard Twining, and Henry G. Weston, Jr.

Bi-weekly samples of Spotted Towhees were collected on neighboring ranches. Gross analysis of the stomach contents of these birds provided some information on food habits. Five Spotted and five Brown towhees were collected for dissection of hind limb musculature. Skeletons used for the analysis of hind limb osteology were in the collections of the Museum of Vertebrate Zoology.

FORAGING BEAT

The foraging beat of the Spotted Towhee must provide sheltered soil cover in which the birds may find their food by scratching. Spotted Towhees rarely forage in areas which are not screened from above by overhanging vegetation, and even more rarely do they search for food in bare or sparsely covered soil. Shelter may be afforded by a variety of plants but the soil cover is almost always composed of leaf litter and humus. Vegetation which supplies both overhead screening and adequate leaf litter is especially favored. In addition to overhead shelter many types of vegetation supply lateral screening as well, although this is not so important.

The vegetation in which the foraging beat lies consists of trees, large, isolated shrubs, or brush. The most important tree for foraging Spotted Towhees in this area is the coast live oak (*Quercus agrifolia*). The dense, evergreen foliage of this oak provides excellent overhead cover throughout the year, and the lowest branches often reach nearly to the ground, providing lateral screening as well. Leaf litter under live oaks is usually very heavy. In part this may result from the evergreen habit and in part from the protection of fallen



FORAGING AREAS OF THE SPOTTED TOWHEE. (*Above*) Nearly unbroken leaf litter beneath large Coast Live Oaks (*Quercus agrifolia*). (*Below*) Mixed brush, mainly Poison Oak (*Rhus diversiloba*), Coffeeberry (*Rhamnus californica*), and Snowberry (*Symphoricarpos rivularis*). The Coast Live Oaks upslope supply much leaf litter to the brushy areas below them. Photographs taken May 13 1956, at the Hastings Reservation.

leaves from wind scattering, since the lowest lateral branches act as a windbreak. Under larger, older trees the heavy layer of leaf litter and humus and the dense shade effectively suppress the growth of other plants, and the leaf litter is nearly unbroken. Such oaks represent the optimal undertree foraging sites for Spotted Towhees. (Plate 7.) Areas under blue and valley oaks (*Q. douglasii* and *Q. lobata*) are also frequently used, but less often than those under live oaks. The growth form of these trees does not afford lateral screening, the foliage is deciduous, and since the leaf litter and shade beneath them are not as deep, grasses and other plants are often present in some abundance.

In riparian situations, areas under willows (*Salix* sp.) are frequently used. These trees provide ample leaf litter, overhead screening even when leafless in winter, and in younger trees, which often form dense thickets, lateral screening as well. Although Spotted Towhees do not forage under western sycamores (*Platanus racemosa*) because the crown foliage is too high to provide adequate overhead screening, such trees may be important in adding to the leaf litter found under other riparian vegetation.

Leaf litter under large, isolated shrubs is also used. Large coffeeberry bushes (*Rhamnus californica*) are especially important in this regard. Other trees and tall shrubs less frequently used include toyon (*Photinia arbutifolia*), madroño (*Arbutus menziesii*), and blue elderberry (*Sambucus coerulea*).

A variety of types of brush provide adequate foraging sites. (Plate 7.) The two most important brush plants for towhees are poison oak (*Rhus diversiloba*) and coffeeberry. Poison oak forms dense thickets which supply some leaf litter and adequate cover even after the leaves have fallen. Since poison oak often grows near oaks, leaf litter under such thickets is often built up to adequate proportions by drifted oak leaves. Younger coffeeberry bushes form dense stands which are often utilized. Both plants frequently combine with plants of other species to form suitable foraging sites. Creambush (*Holodiscus discolor*) and snowberry (*Symphoricarpos rivularis*) are important in combination with other shrubs. California blackberry (*Rubus ursinus*) often forms dense thickets under which Spotted Towhees forage, and in addition may overgrow other shrubs such as poison oak and snowberry, affording lateral screening and contributing leaf litter as well. California wild rose (*Rosa californica*), hollyleaf redberry (*Rhamnus crocea* var. *ilicifolia*), coast ceanothus (*Ceanothus ramulosus*), common horehound (*Marrubium vulgare*), black sage (*Salvia mellifera*), and coyote brush (*Baccharis pilularis* var. *con-*

sanguinea) are also used to some extent. Near buildings towhees have been seen to forage under French broom (*Cytisus monspessulanus*).

Spotted Towhees were noted frequently foraging under chamise (*Adenostoma fasciculatum*) and California sagebrush (*Artemisia californica*). However, little litter is derived from the small, narrow leaves of these plants. The litter under these shrubs is derived almost entirely from the leaves of nearby trees and shrubs of other species, such leaves drifting down and becoming entrapped. Oaks are especially important in this regard. Towhees are scarce in large tracts of pure chamise and are found mainly near the edges of such stands where nearby oaks provide leaf litter. It may be that during a series of wet years adequate soil cover may build up under extensive stands of chamise and sagebrush, but at the time this study was made, after about ten years of relatively dry conditions, intrinsic soil cover was sparse.

A variety of plants has been noted as affording lateral screening. In addition to the shrubs mentioned previously, bracken (*Pteridium aquilinum* var. *pubescens*), ryegrass (*Elymus* sp.), oats (*Avena* sp.), young madroños, dragon sagewort (*Artemisia dracunculoides*), and California mugwort (*A. douglasiana*) are important in this regard.

In summary, of all the plants mentioned the oaks are definitely the most important, not only as primary foraging sites but as major contributors to the leaf litter found under other types of vegetation.

In marked contrast to the Spotted Towhee, the Brown Towhee does most of its foraging in open areas near trees or brush which can be used as shelter when danger threatens or as perches for resting and preening between foraging periods. Most of the records for natural situations involve towhees foraging in open grassland near cover. (Plate 8.) Stretches of dense, unbroken grass are unsuitable, for the birds cannot penetrate such areas. Grass must be rather open or, if dense, must be interrupted in some fashion. Well-worn animal trails, especially those of ground squirrels, deer, and rabbits are very important in modifying dense grass, since the towhees can forage along or at the edges of such trails. Height of grass does not seem as important as density, for towhees were often seen foraging along animal trails leading through tall, impenetrable stands of dry grass, especially oats of various species. In the winter, after the rains have broken down much of the once continuous cover of dense spring and summer grasses, towhees are able to forage in the interstices between clumps which are still erect. (Plate 8.) Pairs of towhees watched during the winters of 1953–54 and 1954–55 foraging

almost entirely in grassland thus broken down, were forced to abandon this area each spring after the grass had again formed a heavy cover over the winter foraging grounds. Brown Towhees forage not only in continuous grassland where sufficiently sparse or suitably modified, but on areas of bare soil, where they apparently find seeds which have fallen or been blown from nearby vegetation.

The cover adjacent to the foraging beat is variable. Some of the more important shelter plants are live, blue, and valley oaks, coffeeberry, coast ceanothus, poison oak, chamise, willows, blue elderberries, and California sage.

Brown Towhees often scratch in leaf litter under trees and brush where the terrain is relatively open. They have been seen foraging under oaks, willows, coffeeberry, poison oak, and ceanothus, and here they overlap to some extent with the Spotted Towhees. However, they seldom penetrate far into the very dense brush which is much used by Spotted Towhees. Most of the records of the two species foraging together involve them scratching in leaf litter under live oaks. In some cases leaf litter under trees may be especially important to Brown Towhees. One was noted foraging in leaf litter under a valley oak surrounded by tall, dense oat cover. This roughly circular patch of leaf litter, about 10 feet in diameter, represented an island of suitable foraging area in terrain otherwise unsuitable. The litter was much furrowed and pitted, giving evidence of heavy use.

In addition to natural situations Brown Towhees forage very frequently on roads and paths, lawns, sickled grass fire breaks, and other artificial areas. They are quick to take advantage of any disturbance to habitat which makes it suitable for foraging.

FORAGING METHODS

Although other methods of foraging may be used at certain times, the great bulk of the towhees' diet is obtained throughout the year by ground foraging. Their methods of finding food are similar and involve gleaning exposed food items, mainly weed seeds and insects (Beal, 1910), from the soil surface or obtaining food located by scratching in soil cover or in the upper layers of exposed soil.

In general, the nature of foraging, whether predominantly by scratching or by pecking at the surface, is determined by the nature of the terrain traversed. Where the ground is exposed or soil cover is either sparse or interrupted, foraging is mainly by pecking at the surface. Where the ground is covered by leaf litter, humus, and short grass, it is accomplished mainly by scratching. Since the

Spotted Towhee is confined almost entirely to habitat in which soil cover of some sort is present, nearly all its foraging is accomplished by vigorous scratching. Since Brown Towhees readily use several types of terrain, ranging from sheltered areas with heavy soil cover to completely exposed, bare areas, they use extensively both methods of foraging. For example, Brown Towhees foraging on roads peck at the surface when searching for food along the exposed soil of wheel tracks. However they scratch in litter which has accumulated along road edges and in road centers where leaves have drifted down and become entrapped by low-growing vegetation. Brown Towhees frequenting a dense poison oak thicket, separated from nearly continuous grassland by strips of bare earth about 10 feet wide, foraged mainly by scratching when using the leaf litter beneath the thicket or when in the grassland, but they foraged almost entirely by pecking when using the strips of bare earth adjacent to the thicket. (Plate 8.)

DIFFERENCES IN FORAGING BEHAVIOR

Although scratching is performed in the same general manner by the two species, there are important differences between them in detail. Spotted Towhees are noticeably more vigorous in their scratching motions. A foraging Spotted Towhee keeps the knee joint moderately flexed, the head high, and the tail held in line with the dorsum, or more frequently cocked slightly above the dorsal line. Scratching is accomplished by a sharp backward thrust of both feet simultaneously, the bird at the same time shifting its body backward so that at the end of a scratch the entire bird has been displaced from the point at which the scratch began. At the end of the backward thrust the bird recovers its original position by a short hop forward, and as it lands repeats the backward leg thrust and body shift. The wings and tail are held motionless during scratching. Sometimes the tail appears to be flicked down at the end of a scratch, but it is difficult to tell whether the bird actually depresses the tail or whether it is jarred down as the scratch ends and the bird hops forward in recovery. The strong claws dig into the soil cover, which is kicked as far as three feet to the rear, passing beneath the cocked tail and falling behind the forager. Periods of scratching are followed by a brief inspection of the newly exposed surface, the bird then pecking at bits of food, or resuming its scratching if no food has been uncovered. When one spot has been depleted of food, the towhee then moves to a new spot and resumes scratching. When a Spotted Towhee moves to a spot where the soil cover is intact, it usually scratches very vigorously five or six times in rapid succession, removing the top

layer of soil cover before pausing to search for food. Most of the food is thus found in the middle and lower layers of the soil cover or in the upper layers of the underlying soil after the cover has been removed. After the initial burst of rapid scratching, foraging proceeds in more leisurely fashion.

So strongly fixed in this species is the habit of scratching for food that individuals will sometimes scratch in trees where material has accumulated above the ground. Towhees were seen to scratch on five occasions in material in trees at heights of 4 to 15 feet, twice on the outer surfaces of wood rat houses in live oaks, and once each on an accumulation of leaves in the crotch of a blue oak, on moss growing on the horizontal section of a willow trunk, and in debris in a cavity rotted out in the trunk of a valley oak.

Two published descriptions suggest that there is some geographic variation in the manner of scratching by the Spotted Towhee. Woodbury (1933: 70), writing of *Pipilo erythrophthalmus montanus* in Zion Canyon, Utah, states that scratching is "accomplished by jumping into the air and drawing the feet backward while the upward momentum lasts. Drawing the feet backward and raking trash or leaves at the same time tends to overbalance the body forward. The bird uses several methods to hold its balance, either singly or in combination. Nearly always, the scratching motion of the feet is accompanied by a forward and upward jerk of the tail. Sometimes the wings flutter forward, and always after each scratching stroke the feet are brought forward quickly to catch the body and keep it from falling." In this method of scratching the primary displacement of the body is vertical. In the birds observed at the Hastings Reservation the leap was always forward rather than up, and the scratching motion occurred after the forward leap had been completed. The displacement of the body was always backward and forward, not up and down; the wings were not moved, and the tail was not jerked forward and upward.

Woodbury further states that "sometimes a backward movement of the body is made in jumping and the feet rake the trash while the momentum lasts. This is accompanied by a downward movement of the tail." This method of scratching, apparently used by *montanus* less frequently than the first method described by Woodbury, is invariably used by the towhees observed in this study.

A second suggestion that scratching may vary geographically is found in Dawson's statement (1923: 394): "Towhee is thoroughly at home here, and scratching for food is his job. This he pursues not by the methodical clutch and scrape of the old hen, but by a

succession of backward kicks, executed with spirit by both feet at once, and assisted by a compensatory flash of the wings." This passage seems to have been carried over almost verbatim from an earlier work, Dawson and Bowles' "The Birds of Washington," in which we find the following statement concerning scratching in the account of *Pipilo maculatus oregonus* (1909: 164): "Scratching for food is a favorite employment, and this they pursue not by the methodical clutch and scrape of the old hen, but by a succession of spirited backward kicks executed by both feet at once, and assisted by the wings." That Dawson's later statement is taken from his earlier one is very strongly indicated by the following passage from the preface to "The Birds of California" (1923: v): "inasmuch as a good deal of its [The Birds of Washington] matter was exactly descriptive of conditions obtaining in California, or at least concerned species found in California, it has been unhesitatingly used as a supplementary source-book for 'The Birds of California'." From the above it would appear that Dawson's remarks actually apply to *P. e. oregonus*, which, unlike the towhees at the Hastings Reservation, apparently uses its wings while scratching, perhaps to maintain balance.

When Spotted Towhees forage by gleaning from the surface, they maintain a nearly erect position, and the tail is kept cocked slightly above the dorsum. When food is sighted a bird must bend far forward to pick it up, since the head is carried relatively high above the ground.

Brown Towhees present a markedly different appearance when scratching. They forage from a deep crouch, the knee joint sharply flexed, the feet wide apart, and the tail either in line with the dorsum, or more frequently drooping below it. Some were seen to scratch with the tip of the tail actually touching the ground. Because of the crouched position the head is relatively close to the ground and the birds present a convex dorsal outline, the head and the tail both lower than the back. This contrasts with the concave dorsal outline presented by a scratching Spotted Towhee. The backward thrust of a Brown Towhee is noticeably less powerful and covers less distance than that of a Spotted Towhee. Because of the deep crouch this thrust has a pronounced lateral component, the feet being brought backward and away from the mid-dorsal line, whereas they are brought nearly straight back in the Spotted Towhee. Because of this, and in conjunction with the wider stance, most of the material kicked backward by a Brown Towhee passes to the rear on either side of the drooping tail.

When foraging by pecking at the surface, Brown Towhees also

work from a deep crouch with tail drooping and head held close to the ground. Thus closer inspection of the surface is achieved and the head does not have to be lowered far when food is sighted and picked up.

Three observations of juvenal Brown Towhees suggest that proficiency in foraging by scratching and pecking must be acquired through a process of learning by trial and error. One full-grown juvenile was observed foraging both by scratching and by pecking at exposed food on the soil surface. In addition to scratching in suitable areas, it kicked vigorously several times at a single dead live oak leaf lying on the ground, moving it about and twice getting its claws caught in the partly curled leaf. It then left to forage elsewhere but returned to the leaf several times, kicking it about or picking it up in its bill, holding it for several seconds and then dropping it. An adult and three juveniles were seen foraging together in a flower bed. The young birds picked off and ate the leaves of young plants. One juvenile tried to get at a leaf, one edge of which projected from under a fallen iris leaf. The bird scratched repeatedly at the thick, smooth iris leaf without penetrating it. Finally it reached down and pulled the desired leaf from under the iris. Another juvenile was noted hopping along a road and pausing frequently to pick up dead leaves, twigs, and pieces of dry grass, dropping these objects almost as soon as it had picked them up.

Both species when foraging on a slope invariably scratch facing upslope or cross-slope, and the material being removed is thus prevented from rolling back into the area being excavated. Individuals of both species sometimes change position while scratching and then continue to scratch at the same spot from the new position. Such shifts always involve 90° or 180° rotations, the bird thus scratching across the original axis or along it but facing in the opposite direction. Sometimes the new position may be maintained until the bird moves to another spot, and sometimes the bird may resume its original position after only a few scratches.

There is a difference between the two species in the manner in which they move over the ground while foraging. Considering terrestrial locomotion only, Spotted Towhees almost invariably move from one foraging spot to another by hopping, a series of hops covering distances as great as 30 feet in this fashion. Whether only one hop is made, or a series of hops, both feet are lifted and brought down simultaneously. Brown Towhees nearly always run when distances greater than 10 feet between foraging spots are involved. When Brown Towhees make a series of single hops, pausing between

them to inspect the ground for food, the feet are not moved simultaneously, but one precedes the other. Although both feet may be in the air at the same time, such single hops are in reality "step-hops," the bird taking off and landing on one foot, the other following a fraction of a second later. When a Brown Towhee takes two or more hops in succession, both feet are moved together.

Spotted Towhees appear to be much more at ease while foraging than do Brown Towhees. This is undoubtedly a result of their foraging in sheltered areas. They often forage for several minutes at a time without looking up. An observer, moving quietly, can often work to within a few feet of a foraging Spotted Towhee. Spotted Towhees, foraging toward an observer, will often approach to within a few feet before becoming aware of his presence. In contrast, Brown Towhees, spending much of their time in the open, have the habit of looking up and peering about them every few seconds.

Since Spotted Towhees spend nearly all their time under cover, they are seldom in direct sunlight and usually forage in partial or unbroken shade. The Brown Towhees, spending much time in open areas, are often exposed to direct sunlight. Like most birds, Brown Towhees are quiet during the late morning and early afternoon, especially on hot days. However, in addition to this normal avoidance of activity during periods of high temperatures, they have been seen at times to avoid carefully direct sunshine while foraging on cool days. The most extreme instance of this involved two birds foraging in the shadow of a large valley oak late in the afternoon of April 8, 1955. The weather was cool and a gentle west wind was blowing. Not only did the towhees forage in the shadow of the trunk, but they worked out along the long, thin shadows of the limbs, refusing to enter sunlit areas only a few inches away. Toward the end of the period of observation one bird worked out along a limb shadow about 20 feet long and 6 inches wide. The second bird followed about 10 feet to the rear. When the first bird reached the end of the shadow, it hopped two feet out into full sunlight and stood quietly. The second bird reached the end of the shadow, hopped out into full sunlight about one foot from the first bird, paused briefly, and then hopped three feet farther into a shaded area and resumed foraging. The first bird at once moved to the shaded area and also resumed foraging. Since towhees had been observed foraging in full sunlight on many previous occasions it may be that such elaborate efforts to remain in the shade on a cool day are related to the presence of certain food items in shaded areas. For example, certain terrestrial insects may have been present only in the shaded areas, making these areas more attractive for foraging.

Both species often call or give location notes while foraging, and foraging Spotted Towhees often sing from the ground in the period from late winter to late summer. Brown Towhees do not sing while foraging, but singing by mated males of this species is infrequent at all times.

PERIODS, RATES, AND GROUND COVERED IN SCRATCHING

The greater dependence on scratching by the Spotted Towhee is reflected by the fact that the three longest periods of steady scratching noted in this species were 57.5, 46, and 26 minutes, whereas the three longest periods for the Brown Towhee were 19, 18, and 17 minutes. However, there seems to be no significant difference between the two species as regards rate of scratching. During 25 timed periods aggregating 48.24 minutes, Spotted Towhees scratched an average of 34.0 times per minute, and in 5 timed periods aggregating 21.4 minutes, Brown Towhees scratched an average of 36.0 times per minute. In one period of 9.33 minutes a Spotted Towhee scratched an average of 33.7 times per minute, and in one period of 13.5 minutes a Brown Towhee scratched an average of 31.7 times per minute. Scratching rate in the Spotted Towhee ranged from 14 in 1.75 minutes (8.0 per minute) to a phenomenal 84 in 65 seconds (77.5 per minute). The great variation in scratching rate observed in the Spotted Towhee suggests that in both species this statistic depends primarily on the amount of food present per unit of material being removed.

The amount of ground covered by a bird undoubtedly depends on the denseness of the soil cover, the method of foraging used, and the amount of food present in the foraging area. A Spotted Towhee scratching steadily for 57.5 minutes covered 75 feet in one 14-minute period, with 30 feet of this being covered in 2 minutes. In another period of 11 minutes this bird confined its foraging to an area about three feet square. It is thus impossible to cite an average figure for the amount of ground covered by a foraging individual. There is some evidence which suggests that Brown Towhees that are foraging mainly by pecking range over more ground than those foraging mainly by scratching. Eleven Brown Towhees foraging by pecking covered an average of 5.8 feet per minute, the range 4 to 12.5 feet; eight birds foraging by scratching covered an average of 2.5 feet per minute, the range 0.5 to 5 feet.

FORAGING PITS

As a result of their foraging by scratching, both species make small pits or depressions in the soil or soil cover. Spotted Towhees dig two main types of pits. The first type is nearly circular, deepest

at the anterior end and sloping gently up to ground level posteriorly. These pits may penetrate the soil cover and reach the soil, or may be confined to the cover when it is thick. Five such pits averaged 3.85 × 3.7 inches and 1.2 inches deep. The other type of depression excavated by Spotted Towhees is larger and oval rather than round. Three such pits averaged 8.2 × 3.5 inches and 1.7 inches deep. The extreme in shallow scratching was accomplished by one Spotted Towhee which removed the topmost layer of mixed sycamore and live oak leaf litter over areas 18 × 10 and 8 × 6 inches, exposing the underlying damp litter.

Brown Towhees tend to dig somewhat shallower pits resembling the oval type of pits excavated by Spotted Towhees. Nine averaged 8.4 × 5.0 inches and 0.71 inches deep.

The tendency for Spotted Towhees to dig somewhat deeper depressions than Brown Towhees is probably a reflection of the fact that the soil cover averages deeper in areas where Spotted Towhees forage. Further, the pits made by Spotted Towhees usually penetrate to the damper portions of the soil cover, where insects would presumably be more abundant. Beal (1910: 87, 89) noted that the consumption of animal food is greater in the Spotted Towhee (24 per cent of the diet as opposed to 14.26 per cent for *P. fuscus*), whereas the consumption of weed seeds, to be expected on or just below the soil surface, is greater in *fuscus* (51 per cent as opposed to 34.6 per cent for *erythrophthalmus*) (*op. cit.*: 91, 88). The differences in the depths of the pits excavated by the two species may thus be in part a reflection of interspecific differences in food preference.

NON-TERRESTRIAL FORAGING

Although foraging is primarily accomplished by scratching and pecking in the soil and soil cover throughout the year, from the spring through the fall both species find a considerable amount of food above ground. Foliage foraging by Spotted Towhees was observed on 31 dates falling between January 23 and December 31. Seventeen were in May, 4 in June, 3 in July, and the remaining 7 between September and January. In most instances one or more birds were noted pecking at leaves and branches, and at lichens hanging from them, but it was not possible to see what they were eating. Birds took caterpillars 6 times, beetles once, and an unidentified insect once. On 26 dates foliage foraging occurred in either live or valley oaks, and on one date each it occurred in an unidentified oak, a coffeeberry bush, a toyon, a willow, and a California blackberry bush.

Foliage foraging by Brown Towhees was noted 29 times on 19 dates

falling between February 25 and September 28. Six dates were in April, 6 in May, 1 in June, 2 in July, 2 in August, 1 in September, and 1 in February. Pecking was directed at leaves, branches, oak catkins, lichens, blades of grass, and low annuals. Only twice was the nature of the food being eaten determined, one towhee taking an insect larva and three capturing grasshoppers in a blue oak. Foliage foraging took place on grass 8 times, low annuals 5 times, blue oaks 4 times, valley oaks 4 times, live oaks twice, and once each on coast ceanothus, common horehound, chamise, a black cottonwood (*Populus trichocarpa*), an unidentified plant, and an unidentified shrub.

In the spring both species fed on the seeds, seed capsules, and bracts of miner's lettuce (*Montia perfoliata*, Table 1). The stomachs of 19 of 29 Spotted Towhees collected between April 14 and June 8, 1955, contained remains of this plant. The stomach of a Brown Towhee collected on April 15, 1955, contained seeds and pieces of seed capsule of *Montia*.

From early July to late December various fruits are prominent in the diets of the towhees. Forty-two observations were made of Spotted Towhees eating elderberries (*Sambucus coerulea*) between July 12 and September 23, and for Brown Towhees 31 observations were made between July 13 and October 15 (Table 1). Since July, August, and September are the hottest and driest months of the year at the Hastings Reservation, elderberries are probably important to both species as a source of water. Although the overlap between the periods of feeding on elderberries by the two species seems almost complete, there is some evidence that in certain years one species may start using this food source earlier than the other. Between July 26 and September 5, 1954, Spotted Towhees fed on elderberries on 12 days, of which nine fell between July 26 and August 14, and three between August 16 and September 1. Brown Towhees fed at the same bushes on 10 dates during this period. Eight fell between August 15 and September 5, with single records for August 3 and 9.

The methods of feeding on elderberries are much the same in both species. Most frequently a bird will select a perch near a cluster of berries; usually this is a branch just above or below a cluster, the forager reaching up or bending down to detach single berries. Often a towhee will perch with one foot on the stem of a cluster and the other on the cluster itself, reaching down for the fruits. Since the clusters hang from the ends of long, pliant branches a perch offering firm support is often hard to find, and a bird may move about for some time before finding a secure position from which to feed. Sometimes a towhee may be unable to find a suitable perch and give up

TABLE 1

MONTHLY RECORDS OF FOOD ITEMS EATEN

Plant	*Part eaten*	*Towhee*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Montia perfoliata	Seeds, capsules, bracts	*erythro.*				10	10	3						
		fuscus				1	1							
Sambucus coerulea	Berries	*erythro.*							14	25	3			
		fuscus							13	12	5	1		
Rhamnus californica	Berries	*erythro.*								3	36	11	8	2
		fuscus								1	16	10	3	2
Rhamnus crocea	Berries	*erythro.*							1	8	5			
		fuscus								4				
Rhus diversiloba	Drupes	*erythro.*	1									1	4	1
		fuscus	2	2										
Symphoricarpos rivularis	Berries	*erythro.*	3									1		1
		fuscus												
Ribes divaricatum	Berries	*erythro.*						1	3					
		fuscus												
Quercus sp.	Acorns	*erythro.*	16	19	8	3		1				1	9	8
		fuscus		1	1								2	3

its efforts to reach a cluster. Several times towhees tried to feed from an unsteady perch, lost their balance, and fell.

A second and less frequently used method is that of flying up to a cluster, taking a berry on the wing, and then dropping down to a secure perch to eat it. When foraging in this manner, a towhee will look up and eye a cluster, apparently selecting a berry. The bird then flies up to the cluster, beating its wings to maintain position, and grasps a berry in its bill. The wings are then folded, and as the bird falls it detaches the berry with a sharp twist of its head, aided by the inert weight of the falling body. The towhee then drops to a secure perch to eat the fruit. Towhees make repeated trips in this fashion, usually returning to the same feeding perch, but a Brown Towhee that made four trips to a cluster dropped down to a different perch each time. Aerial foraging is apparently used when a bird cannot find a suitable perch within reach of a cluster. Such foraging was noted twice on windy days when the terminal branches from which the clusters hung swayed to such an extent that a forager would have had considerable difficulty feeding from a stationary perch. Aerial foraging does not result from a desire to seek cover while feeding as both species often used an exposed feeding perch after getting a berry on the wing.

In eating, each berry is rolled about in the bill for several seconds before being swallowed. By thus "mouthing" a berry, the skin is broken, the seeds squeezed out, worked to the tip of the bill, and flung aside with a quick shake of the head. The skin and pulp are then swallowed. Bits of skin are often eliminated as the seeds are cast aside but only three towhees were seen consistently to discard the entire skin. Once a juvenile Brown Towhee expelled the seeds and skin of a berry and then reached down, picked up the skin, and swallowed it. Berries are sometimes swallowed whole, but they are always "mouthed" before ingestion, this apparently serving to break the skin. Brown Towhees spend less time "mouthing" and swallow whole berries more often than do Spotted Towhees. As a result they tend to eat berries at a faster rate. Three Brown Towhees averaged 7.5 seconds between berries, and 6 Spotted Towhees averaged 13.5 seconds.

Spotted Towhees ate coffeeberries (*Rhamnus californica*) between August 22 and December 24, and Brown Towhees ate them between August 26 and December 12 (Table 1). The preponderance of September records for both species suggests that coffeeberries are also an important source of water during this hot, dry month.

There is a pronounced difference between the two species in the

methods of feeding on coffeeberries. Spotted Towhees usually detach a berry, grasping it in the bill and freeing it with a combination pull and sideways shake of the head, and take it to cover to eat it. Birds may take berries to the ground under the bush from which the fruit was taken, or fly to cover with them as far as 50 feet. As judged by the remains of berries eaten by Spotted Towhees, the seeds and most of the skin are not swallowed. However, the stomach of a bird collected on October 27, 1955, contained four large pieces of the skin of a fully ripe (i.e., black) berry. Most of the berries eaten are fully ripe, although occasionally partly ripe (i.e., red) berries are taken. Since ripe berries are more easily detached than unripe ones, preference for them may result from this fact rather than from a taste preference. Spotted Towhees occasionally eat berries *in situ*, but this is rarely seen.

In sharp contrast Brown Towhees usually eat berries *in situ*. A feeding bird will work to a secure perch near a berry and then reach forward to peck at it. One or two pecks serve to slit the skin. By repeatedly pecking through this break the pulp is obtained and swallowed. The bill of a bird feeding in this manner soon becomes wet and glistening from the berry juice. Brown Towhees also prefer ripe berries, although they occasionally eat unripe ones. This may reflect a true taste preference. A Brown Towhee eating a ripe berry may detach it after a few pecks. Sometimes the berry is dropped and another chosen; several times Brown Towhees were seen to fly to cover with a berry thus detached. Infrequently they will detach a whole berry and take it to cover after the fashion of Spotted Towhees.

The intersperspecific difference in methods of feeding on coffeeberries reflects the basic difference in foraging behavior between the two species. Spotted Towhees, preferring to forage and feed under cover, are apparently reluctant to eat coffeeberries in the exposed situations in which they are found, whereas Brown Towhees do not require sheltered situations in which to eat this food.

Fruits of the hollyleaf redberry (*Rhamnus crocea*) were eaten by Spotted Towhees between July 25 and September 27 (Table 1). Brown Towhees ate redberries only 4 times, all in August. Both species ate these fruits *in situ*, either biting pieces from them or detaching them and discarding the seeds and sometimes the skins before swallowing them.

It is noteworthy that Spotted Towhees eat elderberries and redberries *in situ*, whereas they usually take coffeeberries to cover. The reason for this may be in the differences among the sizes of the

berries. Thirty-nine elderberries, black in color and not quite ripe, averaged 0.051 ml. in volume, and 24 blue, fully ripe berries averaged 0.083 ml. Twenty ripe redberries averaged 0.2 ml. Ten ripe coffeeberries averaged 1.3 ml. A towhee taking the three smaller kinds of berries to cover would expend considerable energy for a relatively small amount of food. As stated previously, six Spotted Towhees feeding on elderberries *in situ* took an average of 13.5 seconds to detach and eat a berry. Few data are available for the time required by a Spotted Towhee to eat a coffeeberry, for the heavy cover to which berries are taken makes observations difficult. Spotted Towhees taking coffeeberries to cover left the cover after 30, 45, and 65 seconds, and one was seen to peck at a ripe berry for 75 seconds before hopping away. It seems likely that the greater size of the coffeeberries, and the longer time taken to eat them, account for the towhees taking them to cover, as they apparently find enough food in individual berries so that foraging is relatively efficient despite the trips to cover. Since Spotted Towhees spend long periods feeding on elderberries and redberries *in situ*, the attraction of these fruits must be considerable to overcome the natural reluctance of these birds to leave cover.

Poison oak drupes were eaten only once by Spotted Towhees but were eaten 10 times by Brown Towhees (Table 1). On four occasions the birds chewed the drupes before swallowing them. Once a towhee chewed a drupe for several seconds and then dropped it. The drupe was recovered and about a third of the outer, waxy covering of the seed had been removed. It seems likely that when berries are swallowed, the waxy covering is digested and the hard seed defecated. Beal (1910) has indicated that several species of birds use this method of feeding on poison oak drupes. Other species chew off the waxy covering and discard the seed. The Brown Towhee apparently uses both methods of feeding on the drupes.

Snowberries (*Symphoricarpos rivularis*) and straggly gooseberries (*Ribes divaricatum*) were eaten by Spotted Towhees but they were not eaten by Brown Towhees (Table 1). Other fruits eaten once or twice by one or both species were hillside gooseberry (*Ribes californicum*), California blackberry, islay (*Prunus ilicifolia*), toyon, chaparral honeysuckle (*Lonicera interrupta*), manzanita (*Arctostaphylos* sp.), and madroño. Both species were seen several times moving about in dense growths of common mistletoe (*Phoradendron villosum*) but the heavy foliage prevented observers from noting whether or not the birds were actually eating berries.

In the winter acorns form a prominent part of the diet of the Spotted

Towhee (Table 1). Of 48 birds collected between January 5 and April 27, 1955, the stomachs of 27 contained acorn fragments. In eight stomachs these were the most prominent food item present. Between April 27 and October 26 only one stomach contained acorn fragments, that of a bird collected on June 8. In the fall acorns first appeared in the stomach contents on October 27, and from then on they were found frequently until collecting stopped on February 29. The available observations of Spotted Towhees eating acorns leave considerable doubt as to the ability of these birds to open the husks by themselves. Of ten observations, two involved towhees pulling acorns from their cups and carrying them to cover and three involved birds flying to cover with acorns the origins of which were unknown. A towhee was seen eating an acorn under a blue oak but the meat was exposed and had been broken into three pieces when first noted. The following observations indicate that the Spotted Towhee may depend on already opened acorns as a source of food. A Spotted Towhee was seen next to a log on which a chipmunk (*Eutamias merriami*) was eating an acorn. A second chipmunk appeared and engaged the first in a fight. The acorn fell to the ground and the towhee at once took it to cover and ate it. A Scrub Jay (*Aphelocoma coerulescens*) dropped a half-shelled acorn to the ground. Two or three birds made a rush for it but a Spotted Towhee seized it, took it to a perch, ate some of it, and then took it to several other perches. A Spotted Towhee was seen to pick out and eat meat adhering to pieces of acorn husk which had been spit out by mule deer (*Odocoileus hemionus*). A towhee under a valley oak picked up and dropped three acorns, then picked up a fourth with the basal part of the shell already removed so that the meat was exposed, flew to cover with it, and ate it. It would appear that Spotted Towhees eat many acorns which have already been opened, either by other animals or because the shell had rotted out. The two observations of towhees removing acorns from their cups and flying off with them suggests that birds may occasionally open their own. In these cases, however, the acorns may have been split or some breach may have already been made in their husks. No definitive observation is at hand of towhees pounding open whole, sound acorns.

Seven observations of Brown Towhees eating acorns fell between November 14 and March 13 (Table 1). In each case the acorns had already been opened. A Brown Towhee flew to a stump in which Acorn Woodpeckers (*Balanosphyra formicivora*) had stored several acorns. The towhee pecked at one, the bottom of which had already been broken out, until driven away by a woodpecker. One pecked

at a sprouting acorn with half the shell gone. One pecked at an acorn from which one side had apparently been removed some time before, as the exposed meat was brown. On three dates one or more towhees picked meat from pieces of husk which had been spit out by mule deer. A Brown Towhee ate pieces of an acorn which had been crushed on a road, probably by a passing car. All these observations suggest that Brown Towhees do not open acorns themselves but use already opened ones. A final observation pertains to both species of towhee. A Scrub Jay flew to a bush and shelled an acorn. A Plain Titmouse (*Parus inornatus*), a Spotted Towhee, and two Brown Towhees stayed within 4 feet of the jay as it worked, and when the jay flew the other birds followed it.

Observations of other departures from the usual ground foraging are few. A Spotted Towhee was seen to make two nearly vertical flights from the ground, each to a height of about 2 feet, as though hawking insects. Three times Spotted Towhees were seen hopping swiftly through grass, following an erratic, zig-zag course, as though pursuing grasshoppers, and one was seen to chase and eat a grasshopper. Single observations were made of Spotted Towhees eating young valley oak leaves, the blossoms of hillside gooseberry, the blossoms of California blackberry, and the seeds of black sage, all while perched in the plant involved. A brown Towhee was seen to eat two seeds of slender oat (*Avena barbata*) by leaping to them, grasping them in its bill, bending the oat plant down without breaking the stem, and removing the seeds. Another ate three vegetative buds at the stem tips of coast ceanothus. One reached up to peck at the dry flowers of vinegarweed (*Trichostema lanceolatum*), apparently obtaining the few seeds still present. Two towhees pulled at the heads of grass containing seeds. Twice towhees ate the newly grown leaves of valley oaks. Four observations were made of Brown Towhees pulling off and eating blades of newly sprouted grass. Six birds were involved. A towhee pulled off a pod of canyon clarkia (*Clarkia elegans*) and worked it about in its bill as though getting seeds. One ate a small mushroom, and one ate pieces of leaves from a common man-root (*Marah fabaceus*).

SPACING OF FORAGING BIRDS

The spacing of foraging birds is somewhat different in the two species, although there is considerable overlap between them in this regard. For the Spotted Towhee the great majority of records involves birds foraging in twos throughout the year. Members of foraging "pairs" kept well apart in winter, separated by distances

up to 100 feet. The wide spacing of foragers and the dense brush in which they were found made it nearly impossible to "sex" both members of such duos. Pairs, so identified by sex, were the most frequently encountered foraging groups from late February through July. During this season members of a pair often foraged close together, usually keeping 2 to 15 feet apart, a male following his mate as she moved along the foraging beat. In one case the male led the way and the female followed. When members of a pair foraged in opposite directions, becoming separated by 50 to 100 feet, one or the other would start to call after a short time. This usually, but not always, resulted in one bird flying to the other, or in the silent bird turning and foraging toward the calling bird. In winter widely separated sets of two birds rarely showed such integration of movement. Often one bird would fly from the foraging area and the other would remain. If such widely separated sets of two actually represented pairs, the pair bond must be much weaker in the winter than during the period from late winter through the summer.

Single birds, exclusive of juveniles, are often seen throughout the year. These probably represent wandering immatures, and adults which have failed to find a mate. In the fall and early winter, groups of three to six birds, foraging in the same general area, are not uncommon. The relationships of the birds in such groups are not clear. All observations of such "flocks" occurred between August and January.

In the Brown Towhee the evidence is strong that birds remain paired throughout the year, and that the pair bond is strong at all times. Pair reinforcement notes are heard in every month, and vigorous defense of apparent winter territory has been seen several times. The great majority of observations record Brown Towhees foraging in twos. Members of such "pairs" tend to forage close together throughout the year, usually keeping from 1 to 20 feet apart. Occasionally foraging birds may be separated by only a few inches, and once a bird foraging by pecking came so close to another that was foraging by scratching that the latter kicked leaves in its face, forcing it to move.

Members of presumed pairs were seen to wander apart while foraging and in some instances one member might fly to an area 100 to 150 feet away and resume foraging there. In most cases, after a short separation, one or the other would start to call steadily. Several times it was noted that when two birds were foraging together and one flew to an area some distance away, it would call steadily for a short time before leaving and again after reaching the new foraging

area. This often resulted in its partner joining it. From March through June only pairs and single birds were seen. Trios of foraging birds were seen many times from August through February. These appeared to be made up of a pair plus an unattached bird. Often two birds in such a trio foraged close together and the third some distance away. Several times the presumed pair would leave the area, the single one remaining. In other instances the single bird would fly and the pair would remain. Clashes were noted several times between pairs and single birds in such a trio. Groups of four, five, six, and seven birds were seen several times from July to February. The composition of such groups was not determined.

In summary, both species forage mainly in twos throughout the year. Partners in such duos of the Spotted Towhee forage so far apart in fall and winter, and with such little integration of movement, that it is difficult to tell whether they are truly paired or single birds. From late February through July, members of such duos forage close together and are obviously pairs on the basis of sex. At this time integration of movement between members of a pair is high. In contrast, members of duos of Brown Towhees forage close together and show a high degree of integration of movement throughout the year. Foraging and other behavior strongly suggest that such duos represent true pairs.

ASSOCIATED VERTEBRATES

The influence of associated vertebrates on foraging towhees is difficult to assess. As has been previously noted, the trails of ground squirrels, rabbits, and deer are important in modifying grassland so as to create suitable foraging areas for Brown Towhees. Acorn Woodpeckers, Scrub Jays, Merriam chipmunks, and mule deer are important to both species of towhees in providing opened acorns as a source of winter food. On the other hand, competition for food between towhees and other vertebrate species must occur, but without detailed analyses of their stomach contents it is not possible to determine accurately the nature and extent of such competition.

The reactions between towhees and other species of vertebrates are highly unpredictable. Under seemingly similar conditions a towhee may show antagonism toward another vertebrate, or be attacked by it, or the individuals involved may ignore each other. An outstanding example of this involved an area in which as many as five Brown Towhees and four cottontail rabbits (*Sylvilagus audubonii*) foraged in the evening. For several days no intolerance was noted, and the two species apparently ignored each other. On one

evening a towhee and a cottontail were foraging three feet apart when the rabbit suddenly rushed at the towhee and bit at it, the sound of the teeth coming together clearly audible 40 feet away.

The most frequently observed reactions of towhees toward other vertebrates fall into two main categories. First, foraging towhees may disturb, or be disturbed by other animals. Such disturbance is often mechanical. A towhee may cease foraging and make way for a passing deer or rabbit and resume foraging after the other animal has passed. Other disturbances are of a different nature. The sudden appearance of a predator may cause a Brown Towhee foraging in the open to take cover. Three Brown Towhees foraging in an open area for three-quarters of an hour flew to a nearby oak when a Red-tailed Hawk (*Buteo jamaicensis*) flew over. Brown Towhees were seen many times to take cover when Sharp-shinned and Sparrow hawks (*Accipiter striatus* and *Falco sparverius*) approached their foraging areas. The most important source of disturbance comes from the sudden calling or flight of nearby birds. The sudden scream of a Scrub Jay or the squawking of a group of Acorn Woodpeckers will often cause a towhee to interrupt its foraging and either seek cover or stand alert until satisfied that the danger has passed. Often such bursts of sound are ignored. Groups of California Quail (*Lophortyx californica*) suddenly taking flight near foraging Brown Towhees have frightened the latter into flying to cover. Towhees may disturb other birds in similar fashion. Two Brown Towhees foraging near several Oregon Juncos (*Junco oreganus*) flew from and returned to the foraging area several times, the juncos flying and returning with them each time. Repeated disturbances of this nature interfere noticeably with foraging. In one area of extensive grassland, foraging Brown Towhees used a dense poison oak thicket for cover when danger threatened. (Plate 8.) In the late afternoon this thicket also served as headquarters for a large flock of Golden-crowned Sparrows (*Zonotrichia atricapilla*) which foraged out into the surrounding grassland. Sharp-shinned Hawks often flew over the area, apparently attracted by the large numbers of small birds present. Whenever one of these predators appeared the towhees and Sparrows took cover at once. Usually, when the birds took cover no source of alarm was evident to the observer, and the birds often flew back to the foraging area after only a minute or less in cover. It appeared as though the entire group was being frightened into flight by a few nervous individuals reacting to mounting tension resulting from prolonged absence from cover. Regardless of their cause these hasty flights resulted in disrupting the late afternoon foraging of

FORAGING AREAS OF THE BROWN TOWHEE. (*Above*) Ground cover mainly of short, interrupted grass and low annuals; adjacent Coast Live Oaks and Coffeeberry provide nearby cover. (*Below*) An extensive thicket of Poison Oak bordered by bare soil, beyond which lies an extensive area of interrupted grassland. Brown Towhees foraged under the thicket, on the bare soil, and in the grassland. The nearby Valley Oak (*Quercus lobata*) supplied much leaf litter to the thicket. Photographs taken April 22 and March 16, 1956, at the Hastings Reservation.

the birds using the area. For example, on the afternoon of January 26, 1954, foraging Brown Towhees and Golden-crowns flew to cover 11 times between 3:30 and 5:41 P.M., an average of one disturbance every 12.5 minutes. Once, two towhees flew first, the sparrows following them. Another time, the sparrows flew first, a towhee flying up and joining them as they flew over. Once, the sparrows flew to cover, passing over two towhees which continued to forage. It was not possible to determine which species flew first on the other occasions. No apparent cause for these disturbances was noted by the observer during the afternoon, and after most of the flights to cover, the birds returned to the foraging area after only a few seconds. Whether or not the presence of the large flock of Golden-crowns was advantageous to the towhees is questionable. The frequent disturbance to foraging was a definite disadvantage but the presence of so many individuals to spot approaching predators was a definite advantage. However, the hawks frequenting the area may have been attracted in the first place by the large numbers of sparrows present.

Spotted Towhees are rarely subjected to the disturbances just described. Foraging under cover most of the time, they are already sheltered when disturbances occur.

The second major category of reactions between towhees and other vertebrates is that involving intolerance. There is no consistency in the behavior of foraging towhees toward any given species. In some instances the relative abundance of a competing species seems to influence the reactions of foraging towhees toward it. For example, the Fox Sparrow (*Passerella iliaca*), a winter visitant at the Hastings Reservation, forages in similar fashion to the Spotted Towhee and frequents the same types of foraging sites. Yet, no intolerance was ever displayed by either Fox Sparrows or Spotted Towhees foraging as close as one foot apart. A striking example of the apparent lack of friction between the two species was noted on March 22, 1955, at a time when male towhees were markedly aggressive toward other males of their own species. A male scratched vigorously in leaf litter. Suddenly a Fox Sparrow started to scratch in leaf litter 20 feet away, hidden from the towhee by heavy brush. The scratching sounds made by the sparrow were identical to those made by the towhee. The latter at once flew to within a few feet of the sparrow, apparently mistaking it for another towhee. After a brief inspection of the other bird the towhee at once returned to its foraging area. Although the Fox Sparrow is a definite foraging competitor of the Spotted Towhee, it is present in small numbers and is apparently

ignored. Twice Brown Towhees foraged near Fox Sparrows with neither species showing interest in the other. At another time a Brown Towhee watched quietly as two Fox Sparrows foraged and after they had left, it flew down and foraged in the area that they had been using.

Another competitor, the Golden-crowned Sparrow, is an abundant and widespread winter visitant to the Reservation. This species overlaps in foraging behavior and choice of foraging areas with both species of towhees. Golden-crowns forage in completely exposed areas, and they also scratch in leaf litter under trees and at the edges of brushy areas. They frequently forage in company with towhees, especially with Brown Towhees, usually in small flocks, but occasionally large groups numbering 25 to 75 may use a limited foraging area. Their numbers and foraging behavior make them serious competitors. Spotted Towhees were seen to attack Golden-crowns four times, and Brown Towhees attacked them six times. All attacks were directed either at single birds or at individuals which had strayed from a foraging group and had closely approached a foraging towhee. Brown Towhees surrounded by large flocks of foraging Golden-crowns usually ignored them, since an attack by one or two towhees against a large group would be ineffectual. On one occasion two towhees foraged in the midst of a large group of Golden-crowns. After two minutes one towhee ran 50 feet from the sparrows, and the other followed at once. The towhees then resumed foraging about three feet apart, well removed from the other birds. Since at least 30 sparrows were present, it seems unlikely that the towhees could have driven them away by a direct attack, and they moved to a less crowded foraging area.

Oregon Juncos were attacked three times by foraging Brown Towhees. Juncos are resident at the Reservation, but the numbers of the local population are greatly increased in winter by large groups of wintering birds. Strangely, the three attacks noted occurred on May 12, July 19, and September 23, when the numbers of juncos at the Reservation were relatively low. No close contacts were noted between juncos and foraging Spotted Towhees.

Spotted Towhees attacked Mexican Bluebirds (*Sialia mexicana*) three times, on September 21, October 1, and November 7. These dates fell within the period during which the towhees and bluebirds frequently eat coffeeberries, and the intolerance may have resulted from competition for this food. The October clash involved two towhees eating coffeeberries *in situ* unsuccessfully trying to drive five bluebirds from the same bush at which they were eating. The November clash involved a bluebird eating a coffeeberry on the

ground and a towhee perched 10 feet up in a nearby oak. The towhee suddenly flew from the tree and dived at the bluebird, passing about 6 inches above it. The bluebird flew and the towhee continued on its way. The September encounter involved two non-foraging birds, a male towhee and a male bluebird perched 6 feet apart in an oak. The towhee flew twice at the bluebird and the latter rose to meet him each time. After two brief but savage fights the two dropped to limbs about 10 feet apart, and the towhee then flew from the area. Although neither bird was foraging before the encounter, the aggressive behavior of the towhee strengthens the impression that Spotted Towhees may be intolerant of bluebirds during the coffeeberry season. During the rest of the year these species rarely come into close contact. Only one clash was noted between a Brown Towhee and a bluebird; this was on January 20 after the coffeeberries had disappeared.

Contacts between Spotted and Brown towhees were fairly frequent. On 29 occasions foraging individuals of both species were in close contact. In seven cases there were displays of intolerance. Brown Towhees were the aggressors in five cases and Spotted Towhees in two. Intolerant behavior was noted three times in May, three times in August, and once in September. May represents the peak of the nesting season for both species. In August and September the total numbers of each species are at their highest, as second brood juveniles are full-grown by that time. Competition for food must be high in the late summer and early fall. It seems significant that all cases of intolerance between the two species took place either during the nesting season or at a time of year when contacts between individuals would be unusually frequent. There are no records of intolerance from October to April. Apparently the two species are mutually tolerant from mid-fall to late spring, but some aggression may be expected during the breeding and immediate post-breeding seasons. Even during these critical periods there is no consistency in the reactions of the two species toward each other for there were eight instances of close contact between foraging individuals between May and September when no antagonism was displayed.

Miscellaneous cases of intolerance involved a Spotted Towhee attacking a Plain Titmouse (*Parus inornatus*) eating an acorn, a Spotted Towhee trying to drive a White-crowned Sparrow (*Zonotrichia leucophrys*) from a coffeeberry bush, a foraging Brown Towhee twice attacking a Mountain Quail (*Oreortyx picta*) passing by, and foraging Brown Towhees twice attacking House Finches (*Carpodacus mexicanus*).

Other contacts suggest that towhees may at times become curious

and investigate, in a deliberate and unaggressive manner, the foraging areas used by other species. A full-grown juvenal Brown Towhee, foraging 5 feet from a foraging junco, ran at the latter five times. The towhee moved slowly and deliberately, and each time, the junco flew a few feet away and resumed foraging. The impression was not one of intolerance, but merely investigation of the activities of the junco. On another occasion a Brown Towhee quietly watched a Spotted Towhee three feet away as it scratched vigorously in leaf litter. After 1½ minutes the Brown Towhee moved slowly toward the Spotted Towhee, paused 1 foot from it, watched it for 30 seconds, and then slowly moved toward it. When the birds were about 6 inches apart the Spotted Towhee hopped 10 feet away and resumed foraging. The Brown Towhee then moved to the pit dug out by the Spotted Towhee, eyed it for 2 or 3 seconds, and then slowly moved away, paying no further attention to the foraging bird.

INTRASPECIFIC INTOLERANCE

The two species of towhees diverge sharply in the amount of intolerance expressed toward others of their own species while foraging. Foraging Spotted Towhees clashed only eight times. One clash involved two males on April 12, 1955, at a time when many territorial conflicts were noted. The males came together four times, between attacks foraging as close as 2 feet apart. This foraging probably represented displacement activity. The other instances of intolerant behavior occurred in June (2), August (1), November (2), and December (2). The August case involved two birds classed as immatures by the observer, but more probably they were juveniles. One of the June cases involved competition for a restricted food source; a bird that was eating the fruits of hillside gooseberry drove away another towhee which came to the same bush. One of the November cases involved a towhee which was trying to detach an acorn; it drove away a second towhee which landed near it in the same tree.

Fifty-three clashes were noted between foraging Brown Towhees. Of these, 43 involved either adults or immatures (these indistinguishable in the field), four involved adults and juveniles, two involved immatures only, and four involved juveniles only. Of the four clashes between adults and juveniles, one occurred in June and three in July, the latter involving a pair of adults trying to drive out a juvenile. Of the four clashes involving juveniles only, one occurred in June, two in July, and one in August.

The break-down by months of the 43 attacks involving either adults or immatures shows a preponderance occurring from mid-

summer to early winter. Four attacks were noted in July, six in August, six in September, eight in October, three in November, four in December, and seven in January. From February through June there were only five clashes between foraging birds, one each in February, April, and May, two in March, and none in June. Of the 12 clashes observed in August and September, five involved birds feeding on elderberries. Two instances of intolerance involved known immatures observed on November 29, 1955. The birds had been color-banded in fresh plumage on October 13 (Red), October 15 (Orange), and October 24 (Yellow). In hand all were identified as immature on the basis of criteria outlined by Davis (1951: 3). Red and Orange were seen foraging on open ground at the rear of a house, about 35 feet apart. Red suddenly ran swiftly at Orange, covering the entire distance on foot. Orange flew into nearby brush, pursued by Red. A few minutes later Orange and Yellow were noted foraging on open ground in the yard of the house. The birds were about 2 feet apart. Orange suddenly ran about 10 feet from Yellow and resumed foraging, when Yellow suddenly ran at it. Orange flew around a corner of the house and Yellow returned to its foraging site and resumed scratching and pecking. Three minutes later Orange flew around the corner of the house, landed 6 feet from Yellow, and started to forage. After 30 seconds Yellow flew at Orange and the two then flew around the corner of the house, Yellow pursuing. All clashes were unaccompanied by any vocalization. From these observations it would appear that many of the clashes noted were actually between immatures.

The aggressive contacts previously described include only those noted between birds actually foraging and consisted of brief chases without any vocalization. They do not include the more savage attacks seen frequently in the fall and during the late winter and spring. Such attacks are usually signalized by snarling, throaty notes given by the attacker and a decelerating series of "chink" notes given by the attacked bird. This type of clash apparently represents the attempts of established birds to drive intruders from their territories. The brief, non-vocal clashes involving foraging birds apparently represent attempts to drive other birds from the immediate foraging area only.

Several attacks were observed involving duos which had been observed for lengthy periods in the same areas and were assumed to be pairs. These brief encounters resulted in some cases in the departure of the attacked bird from the foraging area, but at other times the birds resumed peaceful foraging in close proximity. In

two cases the attacker rushed at its presumed mate, drove it away, and then foraged in the exact spot where the other bird had been foraging. The most serious competition for food that a paired Brown Towhee faces is from its mate, and it may be that a bird will occasionally attack its mate if it is sufficiently hungry, or if the mate's foraging area is especially attractive.

The most savage attack noted was directed against a Brown Towhee feeding on elderberries 8 feet up. This bird was attacked by a Brown Towhee which flew at it, passing about 1 inch above it. A second Brown Towhee then flew at it, hitting it with an impact heard clearly 60 feet away. The forager was literally knocked from the bush, but returned to the cluster on which it had been feeding, and it in turn attacked and drove off a towhee which came to the bush a few minutes later.

HIND LIMB OSTEOLOGY

Measurements were made of the femur, tibia, and tarsus of the skeletons of 13 *Pipilo erythrophthalmus falcifer* (6 ♂♂, 7 ♀♀) and 10 *Pipilo fuscus petulans* (6 ♂♂, 4 ♀♀). Percentages of the total length of the hind limb made up by the separate elements are presented in Table 2. It is evident that in *erythrophthalmus* the femur is relatively shorter and the tarsus relatively longer. The tibia is about the same in both species. Although differences in the relative proportions of the leg bones are small, the fact that they are present in the same degree in each sex suggests that they are biologically significant. Since the Spotted Towhee moves over the ground mainly by hopping it is likely that the shortening of the femur and the lengthening of the tarsus are associated with this activity. Howell (1932: 533), describing the anatomy of saltatorial rodents, notes that "with saltatory specialization there will be progressive shortening of the

TABLE 2

PERCENTAGES OF TOTAL HIND LIMB LENGTH

	Pipilo erythrophthalmus			*Pipilo fuscus*		
Bone	*Sex*	*No.*	*Per cent*	*Sex*	*No.*	*Per cent*
Femur	♂	6	25.5	♂	6	26.5
	♀	7	25.6	♀	4	26.6
Tibia	♂	6	43.3	♂	5	43.4
	♀	7	43.5	♀	3	43.5
Tarsus	♂	6	31.2	♂	6	30.1
	♀	6	30.9	♀	4	29.9

thigh, and elongation of the foot, while the length of the shank in relation to total limb length experiences a very slight reduction." The slight differences in intramembral proportions of the hind limb of the two species may be a reflection of the greater dependence on saltatory locomotion in *Pipilo erythrophthalmus*. Also, since foraging by scratching involves a forward hop following each scratch it is possible that the longer recovery hop of *erythrophthalmus* is aided by the skeletal structure of the hind limb, this accounting in part for the greater distance covered by each scratch.

HIND LIMB MUSCULATURE

The hind limb musculature of five Spotted and five Brown towhees was examined. Fresh specimens were preserved in a fluid containing absolute methyl alcohol, formalin, distilled water, glycerine, carbolic acid, sodium carbonate, white arsenic, boracic acid, and potassium nitrate. The muscles were removed *in toto* and stored in the preserving fluid. Because of their small size volumetric analysis was not possible, and each was weighed on a Roller-Smith balance to 0.1 mg. Excess preservative was gently blotted from the muscles before weighing. A detailed description of each muscle is omitted, as Stallcup's (1954: 164–175) description of the leg muscles of *Pipilo erythrophthalmus* serves for *P. fuscus* as well. Table 3 presents the relative percentages of the total hind limb musculature of those muscles which showed marked interspecific difference. The symbol "*" following each muscle indicates that relative percentages overlapped in only one specimen; the symbol "†" indicates that there was no overlap between the samples. The following muscles were not considered in this study: *m. iliotrochantericus medius*, *m. iliacus*,

TABLE 3

PERCENTAGES OF TOTAL HIND LIMB MUSCULATURE

Muscle	*Pipilo erythrophthalmus*		*Pipilo fuscus*	
	Range	*Mean*	*Range*	*Mean*
M. iliotrochantericus posticus*	3.21–3.82	3.47	3.77–4.13	4.01
M. piriformis, pars caudifemoralis†	2.75–3.56	3.20	3.58–3.97	3.72
M. iliotibialis†	6.53–8.37	7.48	8.39–9.63	9.02
M. femoritibialis externus & medius†	10.93–12.12	11.39	9.91–10.58	10.40
M. tibialis anticus†	6.45–7.46	7.06	5.69–6.31	5.95
M. extensor digitorum longus*	1.72–2.00	1.93	1.62–1.88	1.77
M. flexor perforans et perforatus digiti III†	2.29–2.50	2.38	2.56–2.93	2.80
M. gastrocnemius*	15.17–16.36	15.67	16.18–17.57	16.57
M. flexor hallucis longus†	5.12–5.90	5.56	3.66–4.38	4.05

* Relative percentages overlapped in only one specimen.
† No overlap between samples.

m. obturator externus, m. extensor hallucis longus, m. flexor hallucis brevis, m. abductor digiti IV, and *m. lumbricalis.* Nomenclature follows that of Stallcup (*op. cit.*). The following accounts are of those muscles listed in Table 3.

M. iliotrochantericus posticus. This is the most powerful muscle rotating the femur forward and inward. Its action tends to bring the lower leg beneath the body and causes the bird to toe in. The greater development of this muscle in *Pipilo fuscus* may account in part for the noticeable lateral component of each scratching motion. Contraction at the beginning of a scratch would cause toeing in and the feet would thus be brought not only backward but laterally as well.

M. piriformis, pars caudifemoralis. This muscle originates from the anteroventral edge of the pygostyle and inserts on the posterolateral surface of the femur near its proximal end. It is thus capable of two functions, acting to pull the femur posteriorly and rotate it in that direction, or to depress the tail and pull it laterally. The caudifemoralis is better developed in the Brown Towhee. This is reflected not only in relative percentages (Table 3) but in the configuration of the muscle itself. In *erythrophthalmus* the caudifemoralis is more band-like and less spindle-shaped. In *fuscus* the anterior portion of the muscle is noticeably expanded (Figure 1).

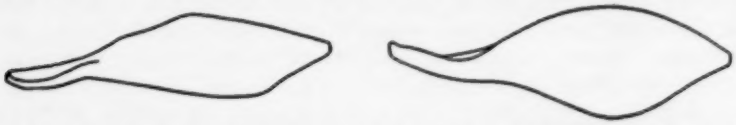


FIGURE 1. Outline drawings of M. piriformis, pars caudifemoralis of *Pipilo erythrophthalmus* (*left*) and of *P. fuscus* (*right*). Posterior is to the left.

As previously mentioned, the Brown Towhee forages with its tail either in line with the dorsum, or drooping below it, sometimes actually touching the ground. When running, the birds cock the tail slightly above the dorsal line. In this case, any downward pull exerted on the pygostyle by the caudifemoralis must be overbalanced by the levator muscles of the tail. However, as Fisher (1946: 666) has noted, the tendinous action of the caudifemoralis could swing the tail from side to side in a running bird, as each leg is brought forward. This would be advantageous as it would aid the bird in shifting its weight to the side of the recovering leg. It is difficult to observe lateral displacement of the tail in a running bird unless it runs directly toward or away from the observer. In the two cases in which I was directly in line with a running Brown Towhee, the lateral displacement of the tail was evident as the bird brought each leg forward. Other observations indicated no such movements of the tail, but none was satisfactory since the birds were observed from an angle. It may be that the increased development of the caudifemoralis in the Brown Towhee is an adaptation to running in this species.

Since the caudifemoralis is also capable of posterior rotation of the femur it is possible that it serves to eliminate a pigeon-toed gait. This would also be advantageous to a running bird. Fisher (*op. cit.*: 699) noted that the great development of the caudifemoralis in the Turkey Vulture (*Cathartes aura*) might account in part for the elimination of pigeon-toed gait in that species.

A noticeable peculiarity in the flight of Brown Towhees may also account for the increased development of the caudifemoralis. When a Brown Towhee makes a

short, relatively slow flight, it frequently jerks its tail downward as it flies; the Spotted Towhee does not do this. In flight the legs are folded against the body and with the femora thus held in a fixed position, contraction of the caudifemoralis is then directed against the pygostyle. Simultaneous contraction of the muscles on each side would jerk the tail downward, as lateral displacement of the tail would be cancelled out. If the femora were held in a fixed position, as in flying, they might be properly regarded as the origins of the caudifemoralis muscles during this activity. The great development of the anterior portions of these muscles in the Brown Towhee indicates that the main action is against the pygostyle, and is correlated with the Brown Towhee's habit of jerking the tail downward while in flight.

M. iliotibialis; m. femoritibialis externus + medius. These muscles are the most important extensors of the tibia. The m. femoritibialis externus and medius, although separate muscles, were removed and weighed as a unit, since the two are so tightly fused that it was impossible to separate them cleanly. Although the combined percentages of the iliotibialis and the two femoritibialis muscles are slightly larger in the Brown Towhee (19.42 versus 18.87), it will be seen (Table 3) that the iliotibialis is proportionally better developed in the Brown Towhee and the femoritibialis muscles better developed in the Spotted. Since the latter are the most powerful extensors of the shank, it is likely that extension of the shank is stronger in the Spotted Towhee. The iliotibialis is only accessory to the other muscles in this function. Since the iliotibialis tends to abduct the hind limb, this action may be stronger in the Brown Towhee.

M. tibialis anticus. This powerful flexor of the tarsus is better developed in the Spotted Towhee.

M. extensor digitorum longus. This muscle, extending the foretoes, is better developed in the Spotted Towhee. It was impossible for me to determine the action of the toes during hopping or scratching. If the foretoes are flexed during these activities, as seems likely, this muscle would aid in recovery. It also aids in flexion of the tarsus, another recovery action.

M. flexor perforans et perforatus digiti III. In both species this is the better developed of the two muscles flexing the third toe. In the Spotted Towhee the average weight of this muscle is 61.3 mg., and of m. flexor perforatus digiti III, 34.8 mg. The corresponding figures for the Brown Towhee are 86.1 and 42.3 mg. Further, m. flex. perf. et perf. dig. III exerts greater leverage, as it inserts on the second and third phalanges, whereas m. flex. perf. dig. III inserts on the first and second phalanges. Relative percentages of the latter muscle are nearly the same in *erythrophthalmus* and *fuscus* (1.35 and 1.38). Since m. flex. perf. et perf. dig. III is better developed in *fuscus*, it seems obvious that flexion of the third toe is more powerful in that species. Since this toe is the most important in cursorial locomotion, it is likely that the greater development of m. flex. perf. et perf. dig. III is associated with that activity.

M. gastrocnemius. This muscle is the most powerful extensor of the tarsus. It is better developed in *fuscus*, probably correlated with the greater dependence on running in that species.

M. flexor hallucis longus. This muscle, a powerful flexor of the hallux, is far better developed in the Spotted Towhee. Although *erythrophthalmus* is about 27 per cent smaller than *fuscus* as judged by fresh body weight (Table 5), m. flex. hall. long. actually weighs more in the Spotted Towhee. Wet weights of this muscle ranged from 135.2 to 153.8 mg. in the Spotted Towhee, averaging 142.8; they ranged from 111.6 to 134.4 in the Brown Towhee, averaging 124.2. The great development in

the Spotted Towhee is obviously correlated with the presence on the hind toe of *megalonyx* of an exceptionally long claw, longer than that of the Brown Towhee (Table 4).

DISCUSSION OF HIND LIMB STRUCTURE

The differences in the relative proportions of the femur and tarsus between *erythrophthalmus* and *fuscus* are undoubtedly genetic. The intramembral proportions of the hind limb of *erythrophthalmus* apparently represent an adaptation to locomotion by hopping. Since forward hopping is also involved in scratching, the proportions of the hind limb may likewise be adaptive in foraging.

Since all the differences between the muscles are quantitative, it is impossible to state whether they are genetic or merely represent hypertrophy through use. In two muscles, m. caudifemoralis and m. flexor hallucis longus, the differences may be genetic. The caudifemoralis is the only muscle examined that shows any difference in appearance in the two species; it is not only larger in *fuscus*, but is noticeably more expanded anteriorly than in *erythrophthalmus*. However, this expansion could be caused by increased use of the muscle to jerk the tail downward during flight. The m. flexor hallucis longus is not only proportionally larger but actually weighs more in the smaller species of towhee. Second, it is functionally associated with the hind claw, which is longer in the smaller species. Third, length of hind claw varies geographically in *erythrophthalmus*, and it seems likely that m. flexor hallucis longus would also vary geographically.

As regards the other muscles, it is impossible to determine whether or not the interspecific differences are genetic. It will be noted that the recovery muscles are better developed in *erythrophthalmus*, which has proportionally larger m. femoritibialis externus + medius, m. tibialis anticus, and m. extensor digitorum longus. Only one recovery muscle (m. iliotibialis) is better developed in *fuscus*, and it is subordinate in function to the femoritibialis muscles in extension of the tibia. Those muscles associated with power are better developed in *fuscus*, namely, m. gastrocnemius and m. flexor perforans et perforatus digiti III.

Well developed recovery muscles would be advantageous to a hopping bird such as *erythrophthalmus*. Strong extension of the tibia and flexion of the tarsus would provide fast recovery, during the split second that the bird is in the air, to a position that would absorb the shock of landing and allow the bird to hop again as soon as it had landed. In scratching, powerful extension of the tibia might allow for recovery from a longer scratch and greater displace-

ment of the body to the rear. The greater development of the m. iliotibialis in *fuscus* may be associated with the tendency of that muscle to abduct the hind limb as well as extend the tarsus. This would be advantageous to a bird running over an uneven surface, as it would provide a bracing action against sudden lurches.

The better developed power muscles of *fuscus* seem to be correlated with the greater dependence on running in that species. In hopping, body weight is supported and moved by the muscles of both hind limbs, but in running the entire weight of the body must be borne and moved forward by one limb at a time. Greater development of power muscles would be advantageous in running as each leg would be able to function more efficiently in locomotion while carrying the whole weight of the body. Recovery muscles would not be so important to a running bird as one leg has a chance to recover while the other is delivering the forward thrust.

As regards the important m. flexor hallucis longus, powerful flexion of the large hind claw might play an important part in assisting the Spotted Towhee to shift its body to the rear when scratching. First, flexion of the hind claw against the surface might actually provide a backward pull, reinforcing the action of other muscles thrusting the body backward. Second, the powerfully flexed hind claw might act as a brace against which other muscles could act in the backward shift of the body. The hind claw would act in a fashion analogous to a spiked shoe, providing a fixed point against which other muscles could operate. The less vigorous scratching of the Brown Towhee might reflect the weaker development of the hind claw and m. flexor hallucis longus in that species, with consequent inability to shift the body as far to the rear at each scratch.

As mentioned previously (pages 135–136), two published descriptions of the scratching of the Spotted Towhee differ in certain details from the scratching observed by me of *P. e. megalonyx* at the Hastings Reservation. The differences in the scratching of *P. e. montanus* in Utah, as described by Woodbury (1933: 70), apparently do not result from a difference in hind claw length in that race, as the average difference in this character between seasonally comparable samples of *megalonyx* and *montanus* is not significant (Table 4), and the two races are similar in body weight (Table 5). Dawson's descriptions of scratching in the Spotted Towhee (1909: 164, 1923: 394) are apparently based on observations of *P. e. oregonus* (see pages 135–136). If this be true, as seems most likely, the use of the wings to assist scratching by that race may result from very weak development of the hind claw. Hind claw length in *oregonus* is significantly smaller

TABLE 4

HIND CLAW LENGTH OF MALE *P. erythrophthalmus*, *P. fuscus*, AND *P. aberti* (APRIL–JUNE)

Subspecies	*Number*	*Range*	*Mean* $\pm \sigma_m$	σ
erythrophthalmus				
megalonyx (Hastings)	13	10.8–14.0	12.22±0.24	0.85
montanus (Utah, Colo.)	10	10.6–12.9	11.58±0.23	0.72
oregonus (B. C., Wash., Ore.)	10	8.5–10.1	9.51±0.18	0.58
fuscus				
crissalis (w. central Calif.)	10	9.6–10.8	10.06±0.13	0.42
aberti				
dumeticolus (Colo. Desert, Colo. R.)	10	9.6–11.7	10.56	

than in *megalonyx* (Table 4), although the latter is a slightly smaller bird (Table 5). The weakly developed hind claw of *oregonus* would probably function less efficiently in assisting the backward shift of the body during scratching. This would cause an overbalancing forward, and the flick of the wings at each scratch might well act to speed recovery to a balanced position. Further observations on scratching by *montanus* and *oregonus*, and investigation of the hind limb musculature of the two races, with special reference to m. flexor hallucis longus, would be worth-while.

Considering the interspecific differences between individual muscles, there can be no question that the better developed muscle is capable of more powerful action. If the quantitative differences between individual muscles do represent hypertrophy through use, rather than genetic adaptations, the situation is analogous to that in which athletes develop certain muscles for specific activities. Once developed, these special muscles are more powerful. The same may be true of the two species of towhees. It is possible that the nestlings start out with hind limb musculature that is the same in both species. Because of innate, genetically controlled behavior patterns, juvenal Spotted Towhees instinctively spend most of their time in sheltered areas, where they are forced to hop, and scratch for their food. Juvenal Brown Towhees spend a considerable amount of time foraging in the open, where they can gather food from the surface. For such

TABLE 5

WEIGHTS OF MALE *Pipilo erythrophthalmus* AND *P. fuscus*, MAY AND JUNE

	Locality	*Number*	*Range*	*Mean*
erythrophthalmus				
megalonyx	Hastings	13	34.0–41.2	38.45
montanus	Utah, Ariz.	6	34.3–39.7	38.00
oregonus	Oregon	4	40.2–43.3	41.80
fuscus				
crissalis	w. central Calif.	4	49.6–54.0	52.28

birds running is feasible and advantageous in escaping from danger. The different modes of life imposed on the young birds may well account for the relatively great development of certain muscles in one species, of other muscles in the other. The question of whether muscular differences are inherited or acquired will be settled only by the dissection of nestlings that have not used their hind limbs for either foraging or locomotion.

CONCLUSIONS

In considering posture and hind limb structure as related to both locomotion and foraging, it seems apparent that each species has achieved efficiency along certain lines at the expense of relatively inefficient performance in others. The intramembral proportions of the hind limb and the greater development of recovery muscles in the Spotted Towhee promote proficiency in hopping. This is a cumbersome method of locomotion, since at every hop a bird raises its weight through a vertical component without propelling the body forward. Energy is wasted on this vertical component, and also in absorbing the shock of landing. However, hopping is suited to the terrain in which the Spotted Towhee lives, as there are many twigs, fallen limbs, low-hanging branches, and other obstacles that would repeatedly trip up a running bird. Further, the Spotted Towhee spends nearly all its time under heavy vegetation, and rarely has to run to shelter. As noted previously, increased efficiency in hopping may promote efficiency in foraging by scratching, on which the Spotted Towhee depends almost entirely for finding food.

In *P. e. megalonyx*, at least, the great development of the hind claw and associated m. flexor hallucis longus appear to be adaptations that increase scratching efficiency. The more nearly erect posture of the Spotted Towhee, and its habit of cocking the tail above the dorsum, also make more vigorous scratching possible. However, the same posture is used when the birds gather food from the surface, and here efficiency is reduced, as the head is carried high, the forager cannot inspect the ground closely, and must bend forward to pick up material from the surface. Spotted Towhees, however, rarely gather food from the surface.

The greater development of power muscles in *fuscus* has promoted swift, efficient locomotion by running, feasible in the open terrain in which *fuscus* spends much of its time, and necessary as a means of reaching shelter. Since *fuscus* forages in a greater variety of terrain than does *erythrophthalmus*, we find that it does not rely mainly on either scratching for food or foraging at the surface, but

uses both methods frequently. Its foraging posture, in which the head is carried low, enables the birds to inspect the ground more closely, and they do not have to bend so far forward to pick up food. However, since they scratch from the same posture, we find that scratching is less efficient since the deep crouch reduces the ability to thrust the legs and feet backward as far or as powerfully as could be done if the posture were more nearly erect. Further, reduction of the hind claw and of m. flexor hallucis longus may reduce efficiency in scratching. This reduction may be of advantage in cursorial locomotion, however, as the hind toe is not used in running, and a long hind claw might strike obstructions as the foot is brought forward.

Each species appears to be well fitted for existence in the habitat which it instinctively selects. This has come about either through genetic adaptations in certain structures, through the relative development of certain structures in response to particular demands put on them, or through a combination of both.

TAXONOMIC IMPLICATIONS

Coues (1866: 89) first suggested that the "red-eyed" and "brown" towhees are not congeneric. The red-eyed towhees include *Pipilo ocai* and *P. erythrophthalmus*, and possibly the Green-tailed Towhee (*Chlorura chlorura*). The brown towhees include *Pipilo fuscus*, *P. aberti*, and *P. albicollis*. Davis (1951: 10, 100–101) suggested that the brown towhees might have closer affinities to the genus *Melozone* than to the red-eyed towhees. The present study has indicated that there are definite differences between *Pipilo erythrophthalmus megalonyx* and *P. fuscus crissalis* in foraging behavior and in locomotion, and that these differences are reflected in certain aspects of hind limb osteology and myology. At first glance, this might be interpreted as biological evidence supporting the contention that the red-eyed and brown towhees are not congeneric. However, it is imperative that all species within the genus, as constituted at present, be considered, before any taxonomic significance be ascribed to the interspecific differences in foraging between *erythrophthalmus* and *fuscus*.

In surveying the brown towhees, it is apparent that *Pipilo aberti* may very well occupy a position intermediate between *fuscus* and *erythrophthalmus* as regards habitat preference, and perhaps as regards foraging behavior. Davis (*op. cit.*: 85–86) has reviewed much of the literature dealing with the habitat preferences of *aberti*. The published observations indicate that this species is very wary, and it

inhabits dense vegetation which it rarely leaves. This is suggestive of *erythrophthalmus* rather than of *fuscus*. Further, *aberti* has a somewhat longer hind claw than *Pipilo fuscus crissalis* (Table 4), although the body weights given by Davis (*op. cit.*: 7, 9) indicate that it is a somewhat smaller bird than *crissalis*. This is another approach toward *erythrophthalmus*, and it suggests that there may be a greater dependence on foraging by scratching in *aberti* than in *fuscus*. The apparent intermediacy of *aberti* between *erythrophthalmus* and *fuscus* is even more significant when it is considered that the historical evidence indicates that *aberti* was derived from the brown towhees of the Pacific Coast, of which *crissalis* is a member (*op. cit.*: 98–99). It seems obvious that biological evidence such as foraging behavior, and morphological evidence such as hind limb osteology and myology, cannot be adduced in support of any definitive treatment of the genus *Pipilo* until the range of variation of such kinds of evidence is established for the genus. Further studies are needed on the behavior and internal morphology of all species of *Pipilo*, especially of *aberti*, *albicollis*, and *ocai*, which are virtually unknown from all viewpoints except that of the museum taxonomist.

SUMMARY

The foraging behavior of the Spotted and Brown towhees is described. Spotted Towhees forage almost entirely under vegetation, by scratching in soil cover. Brown Towhees forage in both sheltered and open areas, gathering food either by scratching or by picking up exposed food items from the surface. Spotted Towhees scratch more vigorously than Brown Towhees, and the posture from which they forage is different.

At certain times of the year both species forage part of the time above the ground, obtaining insects and fruits.

Intraspecific intolerance of other foraging birds is much greater in the Brown Towhee.

The osteology and myology of the hind limbs of the two species were investigated. The greater dependence of the Spotted Towhee on foraging by scratching and locomotion by hopping is reflected in the intramembral proportions of the hind limb and in the greater development of certain recovery muscles. The lesser dependence of the Brown Towhee on foraging by scratching and the greater dependence on locomotion by running, are reflected in the better development of certain power muscles.

The methods of locomotion and foraging, and the structure of the

hind limb in each species, are well fitted for the habitat which each species instinctively selects.

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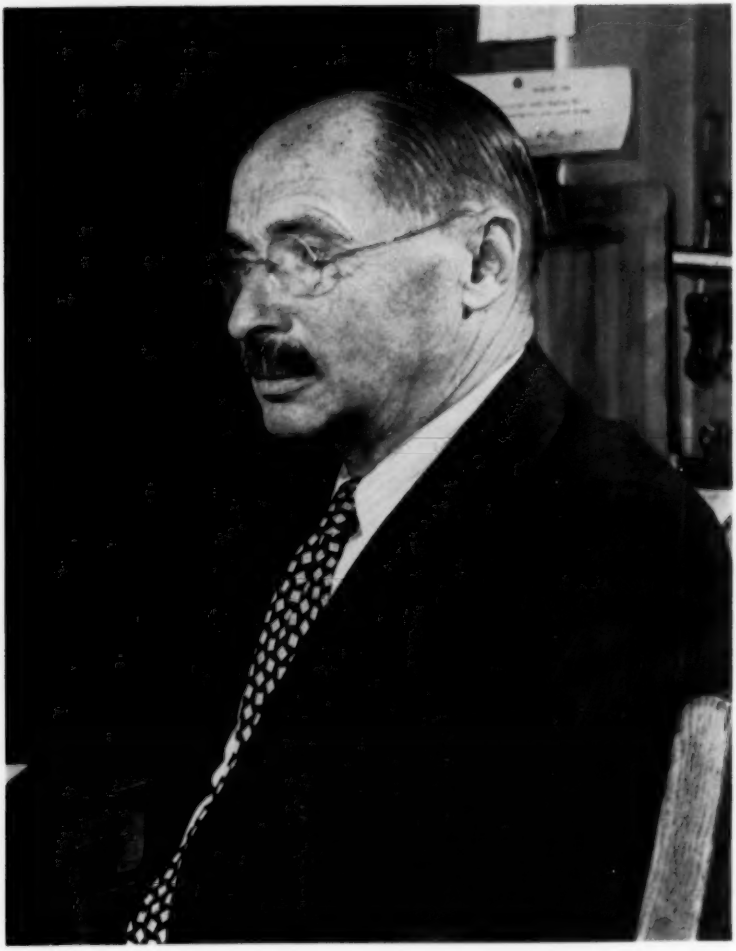

James L. Peters

IN MEMORIAM: JAMES LEE PETERS

BY ALEXANDER WETMORE

JAMES LEE PETERS, Patron, Fellow, and Past President of the American Ornithologists' Union, was born August 13, 1889, in Boston, Massachusetts, the son of Dr. Austin Peters and Frances Howie (Lee) Peters. His ancestry was English, the Peters family having come to the New World about 1634, the Lee family somewhat later, in the early eighteenth century (with a line tracing back to 1592 in Middlesex, England). His father, highly regarded as a veterinary surgeon, was educated at the Massachusetts Agricultural College (now the University of Massachusetts) and had long connection with the Milk Commission of the State of Massachusetts.

During early family residence in Jamaica Plain, James attended Miss Segar's private school, and later, from 1902 to 1908, was enrolled in the Roxbury Latin School. With this preparation he entered Harvard University, where he received his A.B. degree in 1912.

The interest in birds that was to govern his entire life began in early boyhood, fostered by the understanding of his parents. Through his father James came to the attention of A. C. Bent, and in 1904 he was allowed to accompany Bent, C. H. Townsend, and H. K. Job on a summer excursion to the Magdalen Islands. Bent told me long ago how "Jimmy," when on Bird Rock, cautioned to keep away from the cliff edge where the adult members of the party were busy with their cameras, occupied himself by gathering the numerous birds that had been killed by striking the lighthouse and sorting them carefully according to their species and genera, an early indication of his interest in systematics! About this same time James joined the bird-walks conducted by C. J. Maynard, as shown by the lists inscribed in his early journals of birds seen in Franklin Park, the Arnold Arboretum, and other favored spots. Another mentor of this early period was Judge Charles F. Jenney, of whom James often spoke in later years. James also was one of the prime movers in establishing the Norfolk Bird Club in late December 1908, and the following year served as editor of its journal, 'The Wren,' with Joseph Kittredge, Jr., associated with him as business manager, a short-lived venture, but an interesting one.

At Harvard it was natural that James would in due course meet Outram Bangs, with whom he soon developed the close and friendly association that was a major influence in developing the young ornithologist and in training him in the meticulous methods that governed his later work. Following graduation Peters began his travel

years by accompanying an archaeological party from the Peabody Museum at Harvard to Quintana Roo, where he was occupied in making collections, mainly of birds, from January to April 1912. His report on this expedition, which appeared in 'The Auk' the following year, was his first important publication. During the three succeeding field seasons Peters had service with the Biological Survey, U. S. Department of Agriculture (now a part of the Fish and Wildlife Service, Department of the Interior) on a basis of temporary employment in which he was occupied mainly in making collections of small mammals. This work began in 1914, when he travelled from mid-April until June in Alabama, and then in July joined E. A. Goldman and Ernest G. Holt in Arizona, where he continued until October. The following year, from the middle of May to August, Peters made a trip along the South Carolina coast and around Muskogee, Florida, mainly to gather data on Wood Ducks and other migratory birds. In some of the more remote areas, he told me, he was under definite suspicion of being a "revenooer" in search of illicit stills! In 1916, from February until early April, he made studies and collections of the birdlife of the northern part of the Dominican Republic for the Museum of Comparative Zoölogy. And then from the middle of May until the end of June continued with mammal work for the Biological Survey in the broken hill country where the boundaries of Georgia, North Carolina, and South Carolina meet. On his return home, during summer and fall he completed a report on his work in the Dominican Republic, which was published by the Museum the following year.

Service in the U. S. Army in World War I followed immediately in 1917, and presently he was in France. At the close of hostilities he was stationed for a year with the army of occupation in Germany, until in 1919 he was returned to the United States to be mustered out with the rank of second lieutenant. Interestingly enough, his final papers were processed by another ornithologist still in service, Maunsell Crosby, whom he had not previously known.

At this time John C. Phillips was engaged actively in assembling data for his monograph of the ducks and on behalf of the Museum sent Peters to Argentina, where he worked in the late southern winter in Misiones and then moved to Río Negro in northern Patagonia for the summer season. I was in Argentina at the time, engaged in investigations on migratory birds for the Biological Survey, and happily our schedules coincided so that Peters and I travelled together during much of March and April 1921, first along the foothills of the Andes in Mendoza, and later in the Province of Tucumán.

During part of this period W. B. Alexander, travelling in search of some insect or other agency that might check the spread of cactus introduced in Australia, was also with us. On our return Peters and I joined in publishing on the systematics of parts of our collections where we both had obtained representative material.

Until this time Peters had worked regularly with Outram Bangs when he was in Cambridge, but on a volunteer basis. On return from South America he was appointed Assistant Ornithologist under Bangs, his title changing to Assistant Curator in 1928, and to Curator in 1932, the position that he occupied to the end.

There had been further field expeditions in the meanwhile, first to Anguilla in the British West Indies, in February 1922, and then to the Corn Islands in the western Caribbean in December 1927. At the close of this latter survey he continued in January 1928 to eastern Honduras where collections were made near Tela and Lancetilla until April. This was his last major foreign field work as then he became engrossed in studies of collections from other continents, particularly from Africa and Asia, and at the same time began a card catalog of the Museum's specimens of birds that entailed check on the identification of the entire collection. This became the foundation for his Check-list of Birds of the World that was his main occupation for the succeeding years of his life.

Preparation of the volumes of the Check-list involved a vast amount of labor. The last authoritative world-list had been that of R. Bowdler Sharpe, a most useful work but one behind our times due to great increases in knowledge in the systematic field. Furthermore the understanding of relationships and the criteria of distinction for geographic populations as entities had changed markedly. The subspecific concept had broadened, and there had come almost complete acceptance of the trinomial arrangement for listing closely related forms. Also, better understanding of the characters and limitations of genera had brought many changes from the narrower limits assigned by older workers, who often were handicapped by limited material. There were valuable handbooks available for better known areas, but even with these, much search of literature was necessary in any comprehensive systematic studies. Peters' volumes filled the gap in our working libraries admirably and immediately became of major assistance through the world. In fact, it seems reasonable to say that in the widest application they have been among the most valuable of the ornithological publications of their period, since directly or indirectly they have had effect on the work and publication of almost all who are interested in birds. The specialist has used

them as a key to current knowledge of different forms, and judgment expressed by Peters as to relationships has been accepted widely so that his opinions have spread into more popular channels.

The first volume of the series, including the orders through the Falconiformes, was published in 1931 and met with immediate acclaim among fellow systematists. The second volume followed in 1934, and others appeared steadily, to the seventh in 1951, which completed the lower groups of perching birds. The seven volumes with more than 2300 pages of text, are marked throughout by conservative, but at the same time comprehensive, treatment, sound judgment in interpretation, and accuracy in citation. The work stands as a lasting monument to the author. As one recognition of this merit Peters in 1940 was awarded the Brewster Medal of the American Ornithologists' Union for the first four volumes.

While these check-list volumes comprise his major writings, Peters during these years published shorter papers steadily, dealing with special collections that came to the Museum from such diverse areas as Africa, Panamá, Perú, and Borneo. With these were scattered contributions concerned with systematics, nomenclature, and descriptions of new forms and genera, as well as numerous reviews.

While completing the check-list section covering the tropical ovenbirds, woodhewers, and related groups, Peters had arranged with Dr. John T. Zimmer to prepare the text for the volume on the tyrant flycatchers and associated families, as Zimmer had made an extensive review of these groups. Peters himself continued with the first of the oscinine families, writing me that it was interesting again to be studying families of world-wide distribution after many months of occupation with groups found only in the Western Hemisphere. Our final correspondence in this field dealt mainly with problems concerned with the swallows, and it is pleasant to know that he completed this family and also that of the larks. By good fortune the project of the completion of the check-list through a cooperative effort on the part of a number of ornithologists is now well in hand.

In the American Ornithologists' Union, James was elected an Associate on November 28, 1904, at a meeting held appropriately in "Mr. William Brewster's Museum," and remained active in our affairs for a period of more than 37 years. He was advanced to the status of Member in 1918 at a business meeting held in New York City, and of Fellow in 1928. His direct service in Union affairs began almost immediately in 1929 when he was elected to the Council, where he remained continuously until he became Vice-President in

1938. And finally he served for the customary three terms as President from 1942 to 1945. Through the chance of national affairs his term as head of the Union came during the period in World War II when public meetings could not be held so that his was a strictly business administration. He had however served his full time in presiding at general meetings during his 5 years as Vice-President.

In activities concerned with birds of the Boston area Peters became a member of the Nuttall Ornithological Club during his freshman year at Harvard, when he was elected on December 7, 1908, through nomination by William Brewster. From the end of 1922 to 1932 he served as Secretary of the club, then as a member of the Council until December 1939, when he became Vice-President. He was elected President of the organization in March 1942 and served in that capacity until his death.

He was active also in the operations of the Northeastern Bird-Banding Association, being on the Council as one of the vice-presidents from 1938 until his death and serving as Editor of the quarterly magazine 'Bird-Banding,' from 1939 to 1950.

Among other scientific connections, Peters was a member of the International Commission on Zoological Nomenclature, in the end serving as its President. His memberships other than those that have been mentioned, included the Cooper Ornithological Society, the Washington Academy of Sciences, the American Society of Mammalogists, and the Society of Systematic Zoologists. He was also a Fellow of the American Academy of Sciences, a member of Sigma Xi, and was elected to corresponding membership in the Deutsche Ornithologische Gesellschaft, and the Sociedad Ornitológica del Plata, and to honorary membership in the Ornithologische Gesellschaft in Bayern.

Peters' home life was centered in the family farm located at the edge of the town of Harvard, where he resided with his mother following the death of his father. His marriage to Eleanor K. Sweet came in 1932, and in her congenial companionship he continued to live in Harvard, driving daily to Cambridge except in winter, when it was usual for them to move temporarily to an apartment near the Museum. James used to tell me that his main farm crops were Barn Swallows from the old barn, and apples from the orchard! In later years he planted part of the acreage in timber trees and rented out the orchard area.

In addition to his work in science, Peters had many outside interests. In local affairs he took great pride in his membership in the volunteer fire department, where he was secretary and treasurer. For a number

of years he was active in the administration of the Community Memorial Hospital, where he was secretary of the Executive Committee and served also on the Building Committee. From his service in World War I, he was a member of the American Legion, and for seven years was Commander of the local post. Local amateur theatricals comprised another interest through which he appeared in some twenty plays.

In field work and observation Peters had a quick eye, a keen ear, and an interest that never slowed. In the preparation of museum specimens he was skilful, far more rapid than the majority of naturalists, and did not shirk the labor involved in handling the larger and more difficult birds. However, I recall one incident when we were together in the Andean foothills of Argentina, where Jim and I crouched under the shelter of bushes watching a pair of condors circling overhead, each of us hoping silently that the great birds would *not* come within range! At the time we were several miles from our horses, and far from our temporary living quarters, so that a pair of condors would have posed a considerable problem. Fortunately, we had the pleasure of watching their majestic flight until they passed out of sight.

As a man Peters was quiet in demeanor, and at the same time wholly friendly to those of congenial interests around him. In our work together as young men in the field, he had always unfailing acceptance of our circumstances, regardless of whether we fared well or badly in the often bizarre surroundings that attended our mutual desires to investigate the birds of remote or difficult areas. Although short in stature, he was strong and active physically, and unfailingly cheerful with a dry humor that never deserted him.

My own association with him endured through a period of forty years with a steadfast friendship in which we had many differences in professional opinion but with no hint of personal misunderstandings, bickering, or quarrels. In later years Peters and I corresponded with fair regularity, usually regarding various ornithological problems and discoveries. At intervals, more regularly in Cambridge than in Washington, we worked together in the museums, and on weekends made minor excursions afield, sharing our mutual interests on all possible occasions. Inevitably our talk drifted to South America and elsewhere in reminiscences of travels that had given James and the writer the nicknames by which we were known among our more intimate friends.

In his scientific studies and in his writings Peters displayed clear judgment and painstaking meticulous study of available facts that

formed the sound and reasonable basis found throughout his written work. Where questions of nomenclature were concerned, his wise understanding of difficult problems, and his clearcut adherence to the fundamental law of priority that is the only firm and lasting basis for decision left no uncertainty as to his actions. In all these matters he was direct, forthright, and unhesitating in expressing judgment once he was sure of his grounds. In studies of local occurrences he was particularly definite in his refusal to accept unusual records based on casual sight observation, demanding that these be substantiated by a specimen or by some other means concerning which there could be no question.

Peters' assistance was especially valuable in the A.O.U. Committee on Classification and Nomenclature, where he served from the beginning of the work on the fifth edition of the check-list. These activities, and his work on his own world list continued until his death from a heart condition, which came in Mount Auburn Hospital in Cambridge on April 19, 1952. As a posthumous honor, in 1956 the name of James Lee Peters was inscribed on the records of the Union as Patron, through the interest of Mrs. Herbert E. Carnes.

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A NEW BIRD (FAMILY CRACIDAE) FROM THE EARLY OLIGOCENE OF SOUTH DAKOTA

BY HARRISON B. TORDOFF AND J. R. MACDONALD

THE FAMILY CRACIDAE, including the curassows, guans, and chachalacas, ranges in the present day from the lower Rio Grande Valley in Texas south to Argentina. The modern distribution of the family gives no clue to the considerable radiation once enjoyed by the group in what is now temperate North America. Fossil species are known from Tertiary deposits in Florida, Nebraska, and South Dakota. This paper describes a new fossil cracid, older than any previously discovered, from the top of the Chadron formation, lower Oligocene of South Dakota.

The fossil is preserved in fine-grained, fresh-water limestone. Preparation of the specimen in high relief has exposed all of the major skeletal elements except the skull and most of the vertebral column, which probably became disarticulated before the specimen was finally buried although they may lie buried in the slab. The bones, lying more or less in a single plane, are well preserved, although many of the larger ones are moderately to severely crushed. Judging by the fairly close association on the slab of most of the toe bones and the proximity to each other of the limb bones of right and left sides, it seems that the skeleton was partly articulated when buried and that much of the bird was decomposed. Some shifting of individual bones occurred as sediments accumulated over the fossil. At burial it seems that the bird was on its right side, with the wings still articulated and held over the back. The left leg was directed forward and ventrally, and the right leg was forward under the spinal column. Subsequently, the bones of the right wing distal to the elbow became disarticulated and moved behind the sternum. The corresponding bones in the left wing lie in front of the keel of the sternum. The leg bones remained approximately in place except that the toes of the right foot now lie above the supposed original position of the pelvis. The head of the left femur is still closely adjacent to the left acetabulum. Most of the keel of the sternum is well preserved, but the sternal plate is badly crushed. The pelvis is badly crushed and is rotated (in relation to the sternum) so that its left side is up and its long axis is almost at right angles to the long axis of the sternum. (See Figure 1 and Plate 10.)

General proportions and conformation of the individual bones indicate clearly that the Oligocene bird is galliform. Characteristic gallinaceous features are especially evident in the sternum, coracoid,

Procrax brevipes. Photograph of type, SDSM No. 511, × 1½.

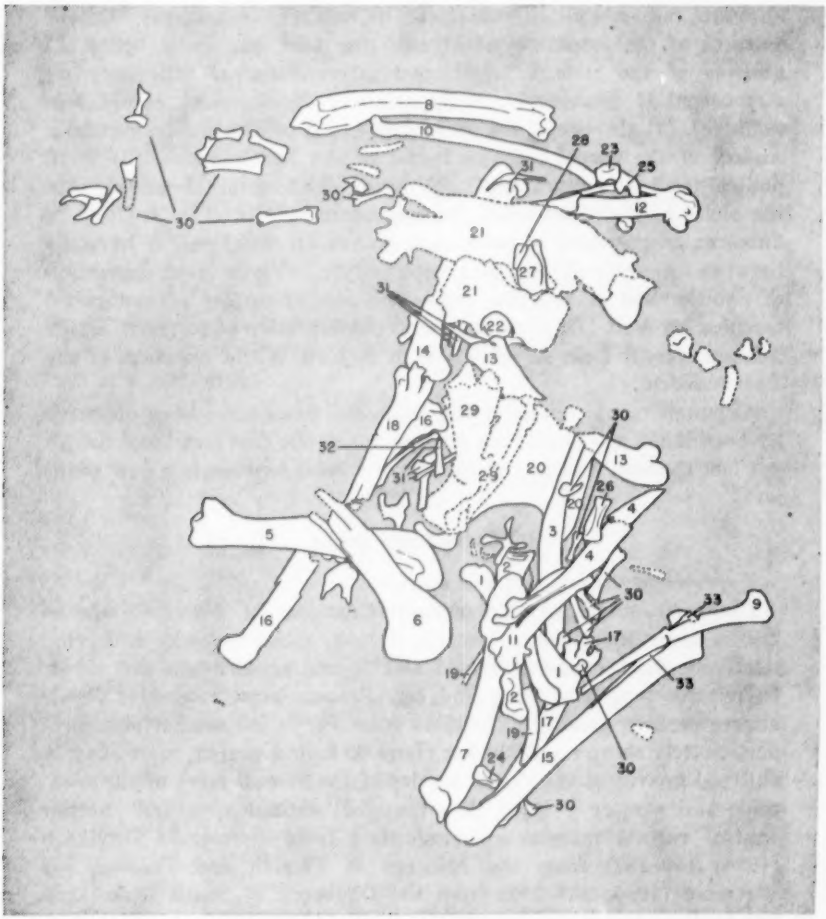

FIGURE 1. **Procrax brevipes.** Diagrammatic drawing, identifying various elements of the skeleton, × ½. 1, left coracoid; 2, right coracoid; 3, left scapula; 4, right scapula; 5, left humerus; 6, right humerus; 7, left ulna; 8, right ulna; 9, left radius; 10, right radius; 11, left carpometacarpus; 12, right carpometacarpus; 13, left femur; 14, right femur; 15, left tibiotarsus; 16, right tibiotarsus; 17, left tarsometatarsus; 18, right tarsometatarsus; 19, clavicles; 20, keel of sternum; 21, crushed pelvis; 22, acetabulum; 23, right scapholunar; 24, left scapholunar; 25, right cuneiform; 26, left proximal phalanx, digit II of manus; 27, right proximal phalanx, digit II of manus; 28, digit III of manus; 29, crushed sternal plate; 30, pedal claws and phalanges; 31, ribs; 32, right fibula; 33, left fibula.

humerus, radius, ulna, carpometacarpus, and tarsometatarsus. Cracid features of the fossil are numerous, the most diagnostic being (1) absence of the strongly developed intermetacarpal tuberosity on metacarpal II (present in all Superfamily Phasianoidea except Numididae), (2) absence of the prominent notch on the posterior palmar surface of the carpal trochlea found in the Phasianoidea, (3) small pollical facet on metacarpal I, (4) flaring of the internal condyle into the shaft of the tibiotarsus, (5) less prominent internal condyle of humerus and absence of prominent groove on distal end of humerus between internal condyle and entepicondyle, (6) prominent depression at anterior end of articular groove on medial surface of metatarsal trochlea for digit III, (7) and general conformation of coracoid, which is less ruggedly built in cracids than in New World members of the Phasianoidea.

Although many details of the Oligocene fossil have been obscured by crushing of the bones, the proportions of the bird and those details not lost through crushing show that the fossil represents a new genus and species.

Procrax new genus

Type.—*Procrax brevipes* new species.

Diagnosis.—Agrees with modern Cracidae as described above. Differs from *Mitu*, *Crax*, *Penelope*, *Ortalis*, and *Penelopina* in having relatively shorter legs (Tables 1 and 2) and smaller feet and claws. In relative length of wing and leg, *Procrax* most resembles *Pipile* among modern genera, but differs from *Pipile* in: smaller size; proportionately shorter and thicker claws on feet; a deeper, more sharply outlined groove at the dorsal border of the sternal facet of the coracoid; and a more pointed (less rounded) carinal apex and anterior ventral carinal margin. Distinguished from *Boreortalis* Brodkorb (1954: 180–182) from the Miocene of Florida and *Palaeonossax* Wetmore (1956: 234–235) from the Oligocene of South Dakota on the basis of larger size and the presumed relationship of *Boreortalis* and *Palaeonossax* to *Ortalis* among modern cracids. *Procrax* shows no close relationship to *Ortalis*. *Boreortalis* and *Palaeonossax* were diagnosed on the basis of characteristics not discernible in *Procrax*.

Measurements.—Depth of carina, from carinal apex to ventral lip of right coracoidal sulcus, 35.4 mm.; depth of carina, from carinal apex to anterodorsal margin of manubrium (estimated), 45; greatest width of anterior end of pelvis (estimated), 36. Length of coracoid, 53.2; of scapula, 75; of humerus, 79; of radius, 71.8; of ulna, 80.7; of carpometacarpus (estimated), 44; of proximal phalanx of digit II

TABLE 1

MEASUREMENTS IN MILLIMETERS OF CRACIDS AND *Opisthocomus*

Species (*number of specimens in parens.*)	1 *Carina depth*[1]	2 *Carina depth*[2]	3 *Width anterior end of pelvis*	4 *Coracoid*	5 *Scapula*	6 *Humerus*	7 *Radius*	8 *Ulna*	9 *Carpometacarpus*	10 *Proximal phalanx of digit II (manus)*	11 *Femur*	12 *Tibiotarsus*	13 *Tarsometatarsus*	14 *Wing (6+8+9+10)*	15 *Leg (11+12+13)*
Opisthocomus hoazin (3)	—	—	25.4	48.6	62.6	69.2	64.6	71.3	38.8	16.8	66.0	89.1	53.8	196	209
Gallinuloides wyomingensis (1)	24.2	(est.) 27.8	—	29.0	42.2	46.8	46.9	49.2	25.8	10.7	40.8	57.6	33.8	133	132
Procrax brevipes (1)	35.4	(est.) 45	(est.) 36	53.2	75	79	71.8	80.7	(est.) 44	15.9	72.3	101.0	65.9	220	239
Penelope purpurascens (3)	37.4	52.8	46	68.5	89.6	103.7	97.6	106.9	56.1	19.5	108.6	149.3	89.2	286	347
P. marail (1)	34	45	42.5	62	74.3	85.5	80.0	88.3	46.0	16.6	95	136	82	236	313
P. obscura (2)	33	45	37.8 (est.)	56.0	77.3	83.7	75.8	82.5	43.6	14.9	96.1	134	81.3	225	311
P. superciliaris (1)	27	37	35	49.6	64.1	69.6	62.4	68.2	36.9	13.0	78.8	114	75.0	188	268
P. argyrotis (1)	23	32	27.8	41.7	58.0	66.2	62.0	67.5	34.8	12.1	68.0	—	55.6	181	—
Ortalis motmot (1)	21.4	28.3	24.0	38.4	50.0	56.7	48.4	52.8	28.7	10.3	64.7	92.8	57.5	149	215
O. wagleri (1)	30.0	39.6	33.0	49.0	66.0	73.2	64.4	68.6	37.5	13.0	78.6	111.0	71.6	193	262
O. vetula (3)	24.7	32.6	25.3	41.3	56.7	61.2	52.7	56.2	30.5	10.8	68.5	103.4	65.7	159	237
O. garrula (1)	23.7	32.0	26.3	46.4	60.5	65.5	58.8	62.9	32.8	12.2	69.6	103.7	68.8	174	243
O. canicollis (2)	28.4	37.7	25.9	45.6	60.9	67.0	59.7	64.5	33.4	12.2	69.2	101.8	63.4	177	234
Penelopina nigra (1)	29.8	39.3	32.3	47.2	63.0	64.6	58.7	63.3	37.4	12.5	82.0	119.0	75.7	178	276
Pipile cumanensis (2)	35.7	47.5	38.0	58.6	78.4	89.1	89.0	96.6	48.2	17.4	79.5	112	68.0	251	260
Mitu mitu (2)	62	77.0	53.2	78.5	99.3	112.5	107.5	120	61.2	21.0	110	166.5	114.1	315	391
Crax alberti (1)	(est.) 62	(est.) 75	51	77	(est.) 110	111.7	110	117	58	18.7	109	166	112	305	387
C. fasciolata (1)	62	76.5	44.9	72.7	98.4	108.4	101.5	110.0	56.5	18.8	106	157	102.8	294	366
C. rubra (5)	67.7	86.5	49.0	83.3	108.5	122.3	119.3	131.3	63.5	21.4	120.8	180.3	118.1	339	419

[1] From carinal apex to ventral lip of right coracoidal sulcus.

[2] From carinal apex to anterodorsal margin of manubrium.

TABLE 2

LIMB PROPORTIONS IN CRACIDS AND *Opisthocomus*

Species (*no. of specimens in parens.*)	*Wing* / *Leg*	*Coracoid* / *Wing*	*Coracoid* / *Leg*	*Coracoid* / *Femur*	*Femur* / *Tibiotarsus*	*Femur* / *Tarsometatarsus*	*Tibiotarsus* / *Tarsometatarsus*	*Humerus* / *Carpometacarpus*
Opisthocomus hoazin (3)	.94	.25	.23	.74	.46	1.2	1.7	1.8
Gallinuloides wyomingensis (1)	1.01	.22	.22	.71	.45	1.2	1.7	1.8
Procrax brevipes (1)	.92	.24	.22	.74	.43	1.1	1.5	1.8
Penelope purpurascens (3)	.82	.24	.20	.63	.46	1.2	1.7	1.9
P. marail (1)	.75	.26	.20	.65	.44	1.2	1.7	1.9
P. obscura (2)	.72	.25	.18	.58	.45	1.2	1.6	1.9
P. superciliaris (1)	.70	.26	.19	.63	.42	1.1	1.5	1.9
P. argyrotis (1)	—	.23	—	.61	—	—	—	1.9
Ortalis motmot (1)	.69	.26	.18	.59	.43	1.1	1.6	2.0
O. wagleri (1)	.74	.25	.19	.62	.43	1.1	1.6	1.9
O. vetula (3)	.67	.26	.17	.60	.41	1.0	1.6	2.0
O. garrula (1)	.72	.27	.19	.67	.40	1.0	1.5	2.0
O. canicollis (2)	.76	.26	.20	.66	.42	1.1	1.6	2.0
Penelopina nigra (1)	.65	.27	.17	.58	.42	1.1	1.6	1.7
Pipile cumanensis (2)	.97	.23	.23	.74	.44	1.2	1.6	1.9
Mitu mitu (2)	.81	.26	.20	.71	.39	.96	1.5	1.8
Crax alberti (1)	.79	.25	.20	.71	.39	.97	1.5	1.9
C. fasciolata (1)	.80	.25	.20	.69	.41	1.0	1.5	1.9
C. rubra (5)	.81	.25	.20	.69	.40	1.0	1.5	1.9

of manus, 15.9; of femur, 72.3; of tibiotarsus, 101.0; of tarsometatarsus, 65.9. Length of toes, estimated by comparison of disarticulated phalanges with toes of *Penelopina nigra* (Fraser), I, 26; II, 39; III, 55; IV, 40. The longest ungual phalanx of the five (length: 10 mm., 8.8, 7.7, 7.7, 6.6) preserved in *Procrax* is approximately equal in length to the shortest ungual phalanx (10.8 mm. on toe IV) of a male *Ortalis canicollis* (Wagler). Three of the five fossil claws are markedly shorter than any in *O. canicollis*, even though the fossil represents a bird larger than the modern *Ortalis canicollis*.

Procrax brevipes new species

Figure 1 and Plate 10

Type.—Skeleton, lacking skull and cervical vertebrae, otherwise nearly complete, in limestone matrix, most bones more or less crushed, preservation otherwise good, No. 511, South Dakota School of Mines and Technology. From fresh-water limestone at the top of the Chadron formation, lower Oligocene, NE ¼ Sec. 4, T1S, R17E, Pennington County, South Dakota. Collected by H. H. Krumvieda.

Diagnosis.—Same as generic diagnosis. In size, larger than male *Ortalis canicollis* (Wagler), smaller than female *Penelope obscura* Temminck, slightly larger than *Opisthocomus hoazin* (P. L. S. Müller).

Procrax brevipes represents the earliest species yet ascribed to the Cracidae. Five other fossil members of the family are known from North America. They are *Ortalis phengites* Wetmore (1923) from the lower Pliocene of Nebraska, *Ortalis tantala* Wetmore (1933) from the lower Miocene of Nebraska, *Ortalis pollicaris* Miller (1944) from the Flint Hill fauna, middle Miocene of South Dakota, *Boreortalis laesslei* Brodkorb (1954) from the lower Miocene of Florida, and *Palaeonossax senectus* Wetmore (1956) from the upper Oligocene of South Dakota. The family, now of Neotropical distribution, seems to have originated in North America and undergone a substantial adaptive radiation there before its retreat southward, which may have been hastened or brought about by competition with contemporaneous species of the Tetraonidae and, perhaps, Odontophorinae.

Ortalis tantala is small, approximately half the size of the modern Chachalaca, *O. vetula* (Wagler). *O. phengites* is somewhat smaller than *vetula*. *Palaeonossax* is approximately the size of *vetula*. *O. pollicaris* is larger than *vetula*, about equalling the modern *O. wagleri* G. R. Gray. *Boreortalis* is still larger, falling between *O. vetula* and *Penelopina* in size. *Procrax* is the largest of the fossil cracids, almost as large as a small guan (*Penelope*). Each of the fossil species except

Procrax is known only from a single bone, permitting no deductions regarding adaptations or behavior of the species in question. *Procrax*, although lacking the extremely important skull, is sufficiently complete to permit some speculation regarding its habits. *Procrax* was a medium-sized cracid probably somewhat superior in flying ability to modern members of the family, but with shorter legs, somewhat shorter toes, and shorter, thicker claws. Judging from these physical characteristics, it seems that *Procrax*, although capable of rapid locomotion on the ground and through trees, probably fed largely in trees and did not scratch for its food. Most modern cracids feed extensively in trees, but many also scratch in ground litter for some of their food.

The relationship to the Cracidae of *Gallinuloides wyomingensis* Eastman (1900), sole representative of the galliform Family Gallinuloididae deserves comment here.

Gallinuloides, from the middle Eocene of Wyoming, was thought by Eastman to be intermediate between true gallinaceous birds and the Family Rallidae. Lucas (1900) studied *Gallinuloides*, known from a complete, fairly well-preserved skeleton, in detail and summarized his findings (p. 84) as follows:

"*Galline Characters.*—Pedate end of internal xiphoid process, arrangement of the costal facets, and shape of the distal end of coracoid.

"*Cracine Characters.*—Blunt, upright, subtriangular costal process, shallow inner sternal notch, small prepubis, proportions of pelvis, elongate tarsus with all the toes on the same level.

"*Peculiar Characters.*—Absence of recurved mandibular process; short, stout, U-shaped furcula with large hypocleideum and articular facet for coracoid."

Lucas concluded that *Gallinuloides* represented a distinct galliform family closest to the Cracidae, the supposed resemblances to rallids being superficial. We have restudied the relationships of *Gallinuloides*, using the excellent plate and figures in Lucas (1900) and a cast of the type courteously furnished by authorities of the Museum of Comparative Zoölogy, Harvard University. We see no basis for maintaining a separate family for this genus. Herewith is a discussion of the "peculiar characters" listed by Lucas. (1) "Short, stout, U-shaped furcula with large hypocleideum"—in size and thickness the clavicles of *Gallinuloides* agree with modern cracids of comparable size and, on a relative basis, with *Procrax;* the hypocleidium of *Gallinuloides* is only slightly larger proportionately and of the same general shape as in the modern cracid genera *Ortalis* and *Pipile*, and

as in *Numida* (the hypocleidium is covered by other bones in *Procrax*); the supposed U-shape of the furcula of *Gallinuloides* is almost certainly the result of distortion through flattening. Our cast of the type shows clearly by the position of the hypocleidium that the furcula was originally oriented in a plane approximately 35° from that in which it now lies. The furcula of a chachalaca such as *Ortalis canicollis* can be superimposed over that of *Gallinuloides* in a manner that convinces us that the original shape of this bone in the fossil differed little, if at all, from that of the modern species. (2) Furcula with "articular facet for coracoid"—Lucas (1900: 81) stated that the presence of this facet ("acrocoracoid process") served to separate *Gallinuloides* "from all existing Galliformes." Actually, a distinct facet on the clavicles for articulation with the coracoid is a distinctive feature of cracids of the Subfamily Penelopinae, although this facet is weakly developed or lacking in the Subfamily Cracinae and in the Phasianoidea. The furcular facets in *Gallinuloides* and in modern cracids seem essentially identical. (3) "The mandible is stout and imperforate, and while it has a blunt angular projection, the recurved process so characteristic of the Galliformes is lacking. This is the most notable departure from the galliform structure found in the skeleton" (Lucas, 1900: 80). This projection, the postarticular process, is not so uniform in the Galliformes as might be supposed. Although it is well developed in the Phasianoidea, it is reduced to a small, sharp point in the Opisthocomidae, and varies in the Cracidae from small and straight in *Pipile* to well-developed in *Penelope* and *Crax*. Furthermore, the process can readily be broken off, as shown by its frequent accidental absence in modern cracid skeletons in museum collections. Re-examination of the original specimen of *Gallinuloides* might establish whether the process has been lost through accident or is actually small and blunt. In either event, this does not seem to be a valid basis for establishment of a separate family.

An additional point mentioned by Lucas (1900: 83) is that in *Gallinuloides* "the tarsus is longer in proportion to the tibia than in any other species examined." This is an error. The tarsometatarsus of *Gallinuloides* measures 33.8 mm., not 45 as stated by Lucas. The ratio of tibiotarsus to tarsometatarsus is not 1.27 as Lucas said, but 1.7, which agrees closely with the corresponding ratio in *Procrax* (1.5) and in modern cracids (1.5–1.7). The notches on the posterior border of the sternum in *Gallinuloides* agree with those of the Cracidae and differ from those of the Phasianoidea in that the internal notch is shallower than the external notch. The hind toe of *Gallinuloides* is inserted at the same level as the anterior toes; this also serves to distinguish the Cracoidea from the Phasianoidea.

Procrax seems to be intermediate between *Gallinuloides* and modern cracids. Although *Procrax* is larger than *Gallinuloides*, the two agree in proportionate length of limb bones (Table 2), in each having a rather deeply keeled sternum with the carinal apex fairly pointed and produced well forward and the anterior ventral carinal margin little rounded, and in having, for cracids, short legs, short toes, and short, thick claws. We think relationships among *Gallinuloides*, *Procrax*, and other cracids can be shown best by placing *Gallinuloides* and *Procrax* in a separate subfamily, Gallinuloidinae, in the Cracidae. Uniting the Gallinuloididae with the Cracidae extends the geologic range of the Cracidae to middle Eocene. The groups should stand as follows:

Order Galliformes
  Suborder Galli
    Superfamily Cracoidea
      Family Cracidae
        Subfamily Gallinuloidinae (*Gallinuloides*, *Procrax*)
        " Penelopinae
        " Cracinae
        " Oreophasinae

Miller (1953: 485–488), discussing a Miocene opisthocomid, *Hoazinoides*, showed that the fossil hoatzin resembled *Ortalis* in shape of brain case. He thought that this should be interpreted as indicating relationship between the two groups, but admitted the possibility that the similarities might have developed independently.

Opisthocomus, *Procrax*, and *Gallinuloides* have closely similar limb proportions (Table 2). There are, of course, many peculiar features of the skeleton of *Opisthocomus* which are not shared by the cracids. Even so, the bones of the appendicular skeleton of *Opisthocomus* look essentially galliform. Characters shared by *Opisthocomus* and the cracids but lacking in the Phasianoidea include absence of the intermetacarpal tuberosity on metacarpal II, absence of the prominent notch on the posterior palmar surface of the carpal trochlea, small pollical facet on metacarpal I, less prominent internal condyle of humerus and absence of prominent groove on distal end of humerus between internal condyle and entepicondyle, internal notch on posterior border of sternum shallower than external notch, hallux inserted on same level as anterior toes, and prominent depression at anterior end of articular groove on medial surface of metatarsal

trochlea for digit III. Also, some cracids, for example, *Pipile*, agree with *Opisthocomus* in the small size of the postarticular process on the lower jaw. The well-known peculiarities of the pectoral girdle and skull of *Opisthocomus* as well as other distinctive characteristics certainly warrant family and probably subordinal status for the bird. The hoatzin-cracid resemblances described by Miller (1953) and by us above, however, constitute evidence that both groups of birds were derived from the same primitive galliform stock. The fact that *Procrax* and *Gallinuloides* are closer than modern cracids to *Opisthocomus* only in proportions, as far as we can tell, suggests that the common ancestral stock was cracid-like and that the peculiarities of *Opisthocomus* are secondary specializations rather than primitive characters. The shape of the cranium of *Gallinuloides* is somewhat intermediate between that of modern cracids and *Opisthocomus*, but the significance of this is impossible to determine because details of the structure of the skull in *Gallinuloides* have been lost.

The primitive characters of cracids and *Opisthocomus* are shared, at least to some extent, by the families Megapodiidae and Numididae. Detailed study of these families might show that the current classification which distributes these geographically peripheral, probably primitive groups among the two suborders and two superfamilies of the Galliformes is in error. Especially suggestive in this connection is *Filholornis* Milne-Edwards, from the late Eocene of Europe, which "seems also to be related to the cracids, and at the same time to suggest a link with the hoatzin" (Howard, 1950: 13).

Specimens examined.—*Gallinuloides wyomingensis*, 1 (cast); *Procrax brevipes*, 1; *Mitu mitu*, 2; *Crax alberti*, 1; *C. fasciolata*, 2; *C. rubra*, 5; *Penelope purpurascens*, 3; *P. marail*, 1; *P. obscura*, 2; *P. superciliaris*, 1; *P. argyrotis*, 1; *Ortalis motmot*, 1; *O. wagleri*, 1; *O. vetula*, 4; *O. garrula*, 1; *O. canicollis*, 2; *Penelopina nigra*, 1; *Pipile cumanensis*, 2; also *Megapodius*, various *Phasianoidea*, and *Opisthocomus hoazin*, 3.

ACKNOWLEDGMENTS

Alden H. Miller and Frank A. Pitelka, of the University of California Museum of Vertebrate Zoology, and Herbert Friedmann, of the United States National Museum, generously loaned us skeletons of modern cracids for comparative purposes. A. S. Romer and Ruth W. Norton, of the Museum of Comparative Zoölogy at Harvard, gave us a cast of *Gallinuloides* which proved most useful. Authorities of the University of Kansas supplied funds for the drawing reproduced here. This drawing was made by Jane S. Mengel.

SUMMARY

Procrax brevipes is described as a new genus and species of the Cracidae from the lower Oligocene of South Dakota. Comparison of *Procrax* to modern cracids and to *Gallinuloides wyomingensis* Eastman from the middle Eocene of Wyoming indicates that *Gallinuloides* is a cracid, closely enough related to *Procrax* to justify placing the two genera in a separate subfamily, the Gallinuloidinae. *Opisthocomus* is compared with cracids (fossil and Recent). Both groups probably were derived from primitive cracid-like ancestors. Brief mention is made of the similarities of hoatzins and cracids to mound-builders and guinea fowl and the possible relationship of these groups.

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CALIFORNIA GULL PREDATION ON WATERFOWL

BY CLYDE R. ODIN

THE California Gull (*Larus californicus*) has been protected in the State of Utah from 1848. Since then its nesting area, and possibly its population, are larger. The majority of publications portray the California Gull as a follower of the plow and a savior of crops. This investigation, however, was made to determine the extent of the predation of the California Gulls on nests and young of waterfowl. My study, lasting from March through August, 1950, was supplemented by less intensive work by John Wunder in 1949. The project was initiated and supervised by Dr. Jessop B. Low and partially financed through the Utah Cooperative Wildlife Research Unit, with the U. S. Fish and Wildlife Service, Utah Fish and Game Department, Utah State Agricultural College, and Wildlife Management Institute cooperating.

Utah's man-made marshes have provided not only an excellent waterfowl habitat but also breeding grounds for the California Gull.

Farmington Bay Bird Refuge with 3,800 acres of marsh and the New State Gun Club with 1,800 acres of marsh in Davis and Salt Lake counties were selected for the study because they are typical of Utah's man-made marshes and have populations of gulls in close proximity to nesting waterfowl. The nesting colony of California Gulls was restricted to 28 small islands of almost one acre in size located entirely within the Farmington Bay Bird Refuge (Table 1). The islands had sparse stands of peppergrass (*Lepidium* sp.), pigweed (*Chenopodium* sp.), and mustard (*Brassica* sp.).

The area of investigation was divided into three units or zones to study gull predation at varying distances from the gull nest sites: Zone One, a circular area with a radius of one mile, located in the lower two-thirds of the Farmington Bay Bird Refuge, included 17 of the 28 gull nesting islands within its boundary; Zone Two, lying mainly within the New State Gun Club, extended one mile from the southwest perimeter of Zone One to the northwest boundary of Zone Three and also extended a mile north from Zone One in the northern part of the refuge; Zone Three, lying entirely within the New State Gun Club, extended one mile from the southwest boundary of Zone Two, to 1,000 feet south of the New State Gun Club headquarters (Figure 1).

A study of California Gull predation on waterfowl was made by Wunder (1949) on the Farmington Bay Bird Refuge and New State Gun Club from June 22 to August 20, 1949. In this study California Gulls accounted for over 100 per cent more destruction on waterfowl

TABLE 1

CALIFORNIA GULL NESTS ON THE 28 ISLANDS AT FARMINGTON BAY BIRD REFUGE, UTAH, MAY 10, 1950

Island Number	*California Gull nests**	*Size of island in square feet*	*Average number of square feet per California Gull nest*
1	0	56,628	—
2	0	47,916	—
3	0	56,628	—
4	0	39,204	—
5	0	56,628	—
6	0	39,204	—
7	0	56,628	—
8	242	56,628	234
9	223	39,204	176
10	259	39,204	151
11	276	56,628	205
12	449	56,628	126
13	349	56,628	162
14	124	47,916	386
15	250	56,628	227
16	167	47,916	287
17	226	47,916	212
18	108	47,916	444
19	14	39,204	2800
20	142	39,204	276
21	240	47,916	200
22	380	56,628	149
23	396	47,916	121
24	415	56,628	137
25	362	56,628	156
26	351	47,916	137
27	203	47,916	236
28	256	47,916	187
Total	5,432	1,354,716	
Average Square Feet per occupied island			184

* Nest count made by William H. Behle, University of Utah.

eggs than all other mortality factors. Wunder also noted two instances of gull predation on young waterfowl.

Nelson (1947, 1948, 1949, 1950, 1951, 1952) conducted nesting studies at Ogden Bay Bird Refuge, Utah, during the period from 1947 through 1952. Gull predation on waterfowl nests was noted in these studies, and the California Gull was by far the most destructive predator on the Refuge.

Wingfield (1951) in a waterfowl productivity study on Knudson Marsh, Utah, in 1950, found that eight per cent of all waterfowl eggs were destroyed by California Gulls.

Williams and Marshall (1938) made intensive duck nesting studies on the Bear River Migratory Bird Refuge, Utah, in 1937, but avian predation was found to be negligible. The California Gull was

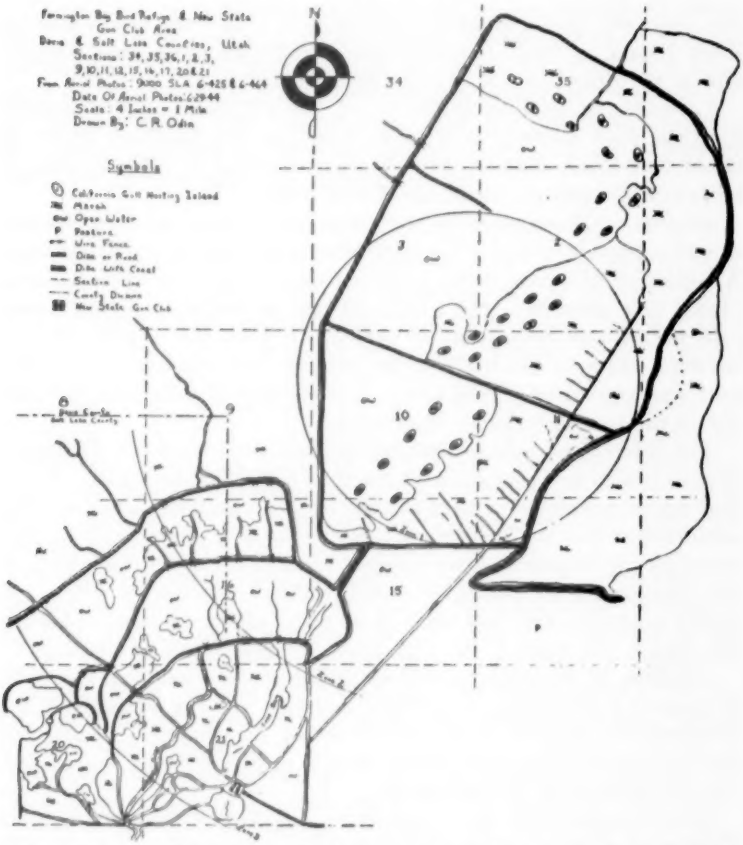

FIGURE 1. The Farmington Bay Bird Refuge study area. Small circles indicate islands used by nesting California Gulls. Scale after reduction: 1 inch = 1 mile.

listed as a predator observed on the area, but no record of nest destruction by gulls was given.

In July 1947, Twomey (1948) observed California Gulls bringing other birds' eggs to their nests on a small island of Deer Flat Refuge in southwestern Idaho. The eggs brought to the gull nesting island were mostly those of Cinnamon Teal (*Anas cyanoptera*), Ring-necked Pheasant (*Phasianus colchicus*), Coot (*Fulica americana*), Black-necked Stilt (*Himantopus mexicanus*), and Eared Grebe (*Colymbus caspicus*).

Sugden (1947) found Ring-necked Pheasant, Coot, Shoveller (*Spa-*

tula clypeata), and Cinnamon Teal eggs in California Gull nests on Rock Island in Utah Lake, on the Farmington Bay Bird Refuge, and on the Bear River Migratory Bird Refuge, Utah.

An intensive food habits study of 184 California Gull stomachs from the Bear River Migratory Bird Refuge and Antelope Island in Great Salt Lake, showed that 30 contained eggs of other species of birds and 7 contained ducklings (Greenhalgh, 1952).

Methods of Procedure.—To determine the fate of nests in relation to gull predation, a search for duck nests was made on the study area. A willow shoot about seven feet long and stripped of branches was placed four paces from the waterfowl nest, on either the east or west side, to facilitate relocation. A period of a week was usually allowed between visits to the nests. The position and identification of the nest was located on a field map. The number of gulls near the nest site at the time of location was recorded.

The different degrees of nest concealment, which played an important role with nest success, were rated as good, fair, and poor. Nests under good concealment were entirely hidden from view, and generally necessitated parting the cover to observe the nest proper. Under fair concealment the canopy over the nest was thinner and the contents of the nest would be partially viewed without parting the cover. A poorly concealed nest had little or no cover above the nest, and when the female was flushed, the eggs could be viewed from a distance.

Detection of the Predator.—Four methods were used by the gulls to destroy a duck egg: (1) pecking a hole in the egg at the nest, (2) dropping the egg over water and retrieving the contents, (3) carrying the egg intact to the gull nesting islands or to a favorite loafing site, and (4) swallowing the egg whole.

Since completion of the Farmington Bay Bird Refuge in 1940, the California Gull population has steadily increased. Possibly this increase was caused by a shift in the gull nesting from the islands (Hat, Egg, Gunnison, and White Rock islands) in Great Salt Lake. The two primary causes for this shift possibly were: (1) new nesting areas created by the construction of marshland for waterfowl, and (2) greater availability of food inland. According to Nelson (1945) in 1942, the nesting islands on Farmington Bay Bird Refuge supported a breeding population of 4,000 California Gulls. On May 10, 1950, Behle counted 5,432 California Gull nests on the 28 nesting islands (Table 1). Allowing two birds per nest, a total breeding population of 10,864 California Gulls was calculated for 1950. Thus, an increase of more than 150 per cent in the California Gull breeding population occurred between 1945 and 1950.

Twenty-one of the islands, numbers 8 through 28, contained California Gull nests and were entirely surrounded by water; little or no water surrounded islands 1 through 7, and gull nests were entirely lacking. Absence of water during the nesting season makes the islands easily accessible to predaceous mammals and man and probably accounted for the gulls not nesting on these islands. There was an average of 184 square feet of island per gull nest (Table 1).

GULL PREDATION ON NESTING WATERFOWL

All Waterfowl Species.—The present study is based on 317 nests of 8 waterfowl species: Canada Goose (*Branta canadensis*), Common Mallard (*Anas platyrhynchos*), Cinnamon Teal, Pintail (*Anas acuta*), Gadwall (*Anas strepera*), Shoveller, Redhead (*Aythya americana*), and the Coot.

In Zone One, 19.6 per cent of the 1,186 eggs were destroyed by California Gulls; Zone Two suffered slightly more, with 21.8 per cent of 684 eggs pilfered by California Gulls; and Zone Three, which was farther from the gull nesting islands, suffered the least from California Gull predation. In this zone, 14.7 per cent of the 1,127 eggs were destroyed by gulls.

In the three study zones, 18.3 per cent of the 2,997 eggs were destroyed by California Gulls; 4.7 per cent were destroyed by skunks, flooding, and unknown causes; 12.1 per cent were deserted or infertile; and 64.9 per cent of all eggs hatched successfully (Figure 2).

Almost three times as many eggs were destroyed by the California Gull as by all other causes, thus indicating the destructive potential of this avian predator.

Wunder (1949) found that 11.3 per cent of the 834 eggs were destroyed by gulls, 5.2 per cent were flooded or destroyed by skunks, and 57.9 per cent successfully hatched. In his study more eggs were destroyed by California Gulls than by all other causes. This study again revealed that the intensity of gull predation became less as the distance from the gull nesting island increased. Probably a greater percentage of the eggs would have been recorded as destroyed had his study begun early in the waterfowl nesting season.

In the present study, the Pintail had the highest loss from gull predation, with 25.6 per cent of all eggs destroyed in three study zones. However, in one zone the Gadwall had 57.2 per cent of its eggs destroyed.

Gulls were known to take Cinnamon Teal, Redhead, Pheasant, and Avocet (*Recurvirostra americana*) eggs to their nesting islands before eating them. The majority of the juvenile gulls were only

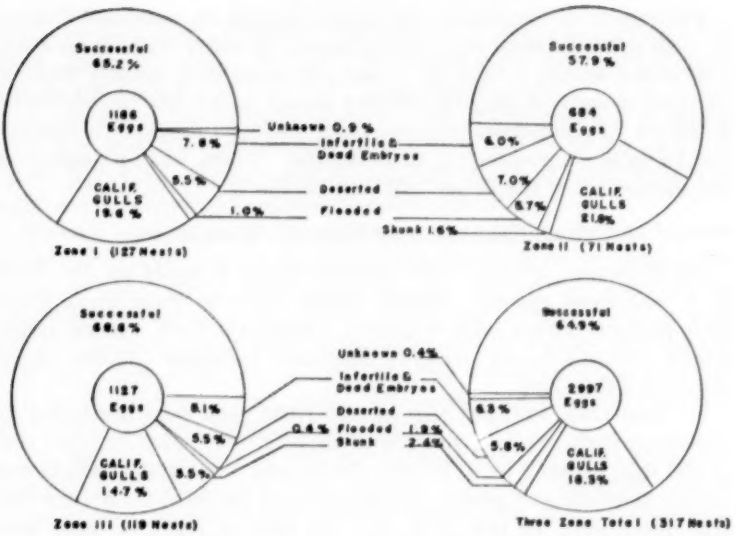

FIGURE 2. The fate of all eggs from 317 waterfowl nests, Farmington Bay Bird Refuge and New State Gun Club, Utah, April 8 through July 27, 1950.

six weeks old and still dependent on their parents for food at the time of greatest nest destruction.

Redhead eggs were found in Cinnamon Teal, Mallard, Pintail, and Shoveller nests. The maximum number of Redhead eggs found in any one of these nests was seven. Of the 50 nests parasitized by the Redhead, 47 were under good and fair concealment, and only three were poorly concealed. Of the parasitized nests that were poorly concealed, 66.7 per cent were taken by California Gulls, and only 10.6 per cent of the parasitized nests under good and fair concealment were destroyed by gulls. Of the 181 nests not parasitized by the Redhead, 19.9 per cent were destroyed by the California Gull.

Redhead parasitism on the nests of the Cinnamon Teal, Mallard, Pintail, and Shoveller did not increase gull predation because: (1) an average of only 2.7 Redhead eggs was laid in each parasitized nest, and (2) the Redhead chose mainly nests of good and fair concealment in which to lay its eggs.

Concealment played a major role in the survival of the waterfowl nests. Gull predation was practically negligible on well-concealed nests; nests of fair and poor concealment suffered the greatest destruction. Of the 139 nests under good concealment only 5.8 per

TABLE 2

PREDATION BY CALIFORNIA GULLS ON DUCK NESTS IN RELATION TO THE DEGREE OF NEST CONCEALMENT AT FARMINGTON BAY BIRD REFUGE AND NEW STATE GUN CLUB, UTAH, APRIL 8 TO JULY 27, 1950.

Study Zone	*Degree of duck nest concealment*	*Duck nests*		*Duck nests destroyed by California Gulls*	
		Number	*Per cent*	*Number*	*Per cent*
1	Good	40	31.5	3	7.5
	Fair	48	37.8	9	18.8
	Poor	39	30.7	13	33.3
	Total	127	100.0	25	19.7
2	Good	29	40.8	1	3.4
	Fair	26	36.6	6	23.1
	Poor	16	22.6	7	43.8
	Total	71	100.0	14	19.7
3	Good	65	54.6	4	6.2
	Fair	33	27.7	7	21.2
	Poor	21	17.7	6	28.6
	Total	119	100.0	17	14.3
TOTAL	Good	139	43.8	8	5.8
	Fair	101	31.9	22	21.8
	Poor	77	24.3	26	33.8
	Total	317	100.0	56	17.7

cent were destroyed by the California Gulls, 21.8 per cent of the 101 nests under fair concealment were lost to gulls, and 33.8 per cent of the 77 poorly concealed nests were pilfered by the gull (Table 2). Wunder (1949) found that 6.8 per cent of 44 nests under good concealment were lost to gulls, 12.5 per cent of 32 nests under fair concealment were destroyed by gulls, and 27.3 per cent of the 22 poorly concealed waterfowl nests were pilfered by gulls.

It was noted by Wingfield (1951) that 11.6 per cent of the 146 Mallard nests under good concealment were pilfered by California Gulls, nine per cent of the 90 Mallard nests under fair concealment were lost to gulls, and 15.5 per cent of the 185 poorly concealed Mallard nests were destroyed by gulls. Gull predation accounted for 13.1 per cent of the 114 Cinnamon Teal nests under good concealment, whereas 10 per cent of the 10 poorly concealed nests were destroyed by gulls. Gull predation was responsible for destruction of 6.7 per

cent of the 67 Redhead nests under good concealment; 9.4 per cent of the 32 Redhead nests under fair concealment were lost to this predator, and 17.4 per cent of the 23 poorly concealed Redhead nests were destroyed by California Gulls. Again the importance of concealment to nest survival is evident.

The largest number of waterfowl nests (67) was successfully terminated during the two week period from June 10 to June 25, 1950, which was also the period of greatest nest destruction by the gulls (Figure 3). Of the 56 waterfowl nests destroyed by California Gulls,

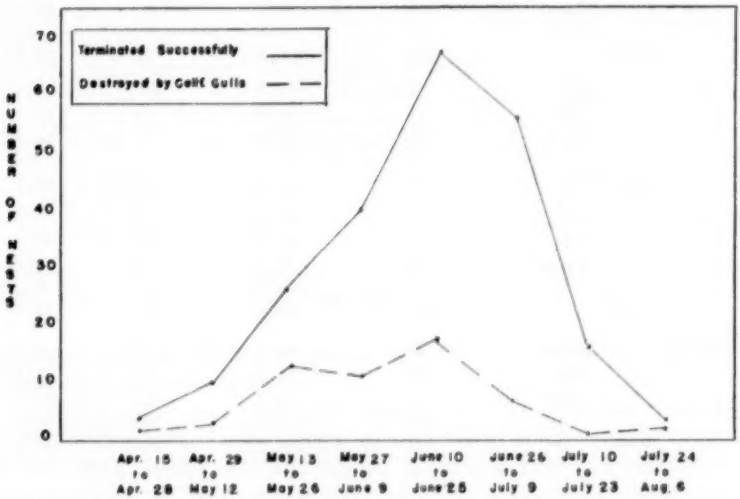

FIGURE 3. California Gull predation on duck nests during eight two-week periods in relation to successfully terminated duck nests, Farmington Bay Bird Refuge and New State Gun Club, Utah, April 15 through August 5, 1950.

82.1 per cent were lost by June 25, and the remaining 17.9 per cent were pilfered after that date. The greater gull predation occurred before June 25 because: (1) waterfowl nesting reached its peak before this date, and (2) the majority of the juvenile California Gulls were still dependent on their parents for food during this period.

California Gulls were observed nearby at the time of location or revisit to 124 nests out of 317 studied. Of these 124 nests 12.9 per cent were destroyed by gulls. In the remaining 193 nest histories no gulls were observed nearby at the time of location or revisit to the nest, yet 20.7 per cent of these latter nests were destroyed by gulls. Thus, it was concluded that the observer was of little or no aid to the California Gull in locating the waterfowl nest.

Canada Goose.—None of the goose eggs was destroyed by California Gulls, but it is known that the California Gull can peck open the eggs and will destroy a Canada Goose nest if given the opportunity. While the goose incubates the eggs, the gander keeps constant guard, and the nest is completely covered whenever the pair leaves.

Cinnamon Teal.—In all study zones 17.4 per cent of the eggs were destroyed by California Gulls, 7.6 per cent were destroyed by other means (skunk, flooding, and unknown), and 62.8 per cent hatched successfully.

Of 67 nests under good concealment only 7.5 per cent were destroyed by California Gulls, whereas, 26.7 per cent out of 45 nests under fair concealment were lost to gulls. Only 5 nests were poorly concealed, but 40 per cent of these were destroyed by gulls.

Common Mallard.—In all three study zones, 21.4 per cent of the eggs were lost to California Gulls, 7 per cent to flooding and skunk predation, and 54 per cent successfully hatched.

Of the 34 Mallard nests under good concealment only 5.9 per cent were destroyed by California Gulls, but 25 per cent of the nests under fair concealment were lost to this predator. The 10 poorly concealed nests suffered the most, with 60 per cent being taken by California Gulls.

Pintail.—In all three study zones the California Gull destroyed 25.6 per cent of the Pintail eggs, 4.7 per cent were taken by skunks, and 60.9 per cent hatched successfully.

Only 7.7 per cent of the nests under good concealment were pilfered by California Gulls, 26.7 per cent of the nests under fair concealment were destroyed by gulls, and 46.2 per cent of the poorly concealed nests were lost to this predator.

On May 10, a Pintail nest was located on gull nesting island number 12. This was the only waterfowl nest observed on the 28 islands in the Refuge, and the nest was completely surrounded by nesting California Gulls. Only one egg was taken by gulls and the remaining six hatched successfully.

Gadwall.—In Zone One, 26.7 per cent of the Gadwall eggs were taken by California Gulls, 57.2 per cent were destroyed by gulls in Zone Two, and no eggs were taken by gulls in Zone Three. In all three zones 18.6 per cent of the eggs were destroyed by gulls, 9.7 per cent were deserted, infertile, or contained dead embryos, and 71.7 per cent hatched successfully.

None of the 13 nests under good concealment was disturbed by gulls, 16.7 per cent of the 12 nests under fair concealment were pilfered by gulls, and 60 per cent of the poorly concealed nests were destroyed by California Gulls.

Shoveller.—In Zone One, 16 per cent of the Shoveller eggs were destroyed by California Gulls, none was lost in Zone Two, and only 6.1 per cent were taken in Zone Three. In all three zones 13.1 per cent of the eggs were taken by gulls, 12 per cent were infertile or contained dead embryos, and 74.9 per cent hatched successfully.

None of the 5 nests under good concealment was disturbed by gulls, 11.1 per cent of the 9 nests under fair concealment were destroyed by gulls, and 33.1 per cent of the 3 nests under poor concealment were pilfered by the California Gull.

Redhead.—In Zone One, 11.8 per cent of the Redhead eggs were destroyed by California Gulls, none was lost to gulls in Zone Two, and 15.9 per cent were destroyed by gulls in Zone Three. In all three zones 11.8 per cent of the eggs were taken by gulls, 12.8 per cent were infertile or contained dead embryos, and 75.4 per cent hatched successfully.

Nests under good and fair concealment were not disturbed by gulls, but 28.6 per cent of the poorly concealed nests were destroyed by California Gulls.

American Coot.—In Zone One, 22.9 per cent of the Coot eggs were destroyed by California Gulls. No Coot nests were studied in Zone Two, and none of the nests studied in Zone Three suffered from gull predation. In the two zones studied, 18.1 per cent of the eggs were destroyed by gulls, 6.8 per cent were infertile or contained dead embryos, and 75.1 per cent successfully hatched.

The 23 Coot nests in Zone One were located in the immediate vicinity of gull nesting islands 12, 13, 14, and 15 and were exceedingly vulnerable to California Gull attack. Hundreds of gulls flew continuously over the nests at all hours of the day. In this zone, 95.7 per cent of the nests were poorly concealed and 4.3 per cent were under fair concealment.

The survival of 69.7 per cent of the Coot eggs in Zone One, with the nests so open to attack by gulls, may be partially explained by: incubation's being shared by both parents (Jones, 1940), and the Coot's being very pugnacious and fighting tenaciously when aroused.

Dummy Duck Nests in Relation to Gull Predation.—To study further the relationship of waterfowl nest concealment to predation, 60 dummy duck nests were made. These dummy nests were constructed to resemble the natural waterfowl nest as closely as possible. In order to determine the range of the predator, 20 dummy nests were placed in each of the three study zones (Table 3). Five nests were constructed with good, 5 with fair and 10 with poor nest concealment in each of the three zones.

TABLE 3

PREDATORS TRAPPED ON DUMMY DUCK NESTS IN RELATION TO NEST CONCEALMENT AT FARMINGTON BAY BIRD REFUGE AND THE NEW STATE GUN CLUB, UTAH, JUNE 3 TO AUGUST 3, 1950

Degree of nest concealment	*Zone*	*Number of dummy nests*	*Number and kind of eggs used*		*Duck Down (nests)*		*Trapping success*			
							Predators		*Other*	
			Species	*Number*	*Amount*	*Number*	*Species Caught*	*Number*	*Species Caught*	*Number*
Good	1	5	Cinnamon Teal	17	Abundant	1	None		None	
			Redhead	8	Fair	2				
			Gadwall	4	Little	2				
Fair	1	5	Cinnamon Teal	11	Abundant	1	California Gull	1	None	
			Redhead	21	Fair	3				
					Little	1	Long-tailed Weasel	1		
Poor	1	10	Cinnamon Teal	43	Abundant	1	California Gull	9	None	
			Redhead	32	Fair	5				
			Gadwall	9	Little	4				
Good	2	5	Cinnamon Teal	5	Abundant	0	California Gull	2	None	
			Redhead	12	Fair	2				
			Gadwall	5	Little	3				
			Mallard	3						
Fair	2	5	Cinnamon Teal	14	Abundant	0	None		Muskrat	1
			Redhead	15	Fair	3				
			Shoveller	10	Little	2				
Poor	2	10	Cinnamon Teal	56	Abundant	5	California Gull	9	None	
			Redhead	22	Fair	4				
			Canada Goose	5	Little	1				
Good	3	5	Redhead	9	Abundant	2	None		None	
			Mallard	8	Fair	2				
			Pintail	4	Little	1				
Fair	3	5	Redhead	19	Abundant	3	California Gull	1	Gadwall	1
			Mallard	11	Fair	1			Yellow-headed-Blackbird	1
					Little	1				
Poor	3	10	Cinnamon Teal	43	Abundant	5	California Gull	6	None	
			Redhead	11	Fair	3				
			Gadwall	25	Little	2	Striped Skunk	1		

Four or five number one steel traps were set in a ring around the nest site. The traps were fastened down and the man-made duck nest placed in the center. The jaws of the traps were covered with vegetation, and shoots from different hard-stemmed forbs placed between the traps. The eggs used in the dummy nests were obtained from deserted waterfowl nests, flooded nests, nests containing infertile eggs or dead embryos, and eggs from partially destroyed nests.

Nests of poor concealment were checked daily while those in good and fair concealment were checked every four or five days.

The California Gull was the only avian predator caught pilfering eggs from the dummy duck nests. Mammals caught included one striped skunk (*Mephitis mephitis*), one long-tailed weasel (*Mustela longicauda*), and one muskrat (*Ondatra zibethica*). The weasel is believed to have been caught accidentally when it was looking for the female duck rather than the eggs.

The importance of the concealment factor in survival of the waterfowl nest was again noted in the dummy nest experiment.

California Gulls were caught at 46.7 per cent of the dummy nests, and only 3.3 per cent yielded mammalian predators. Of the 28 California Gulls caught, 37.5 per cent were caught in Zone One, 39.3 per cent in Zone Two, and 25 per cent in Zone Three. At the 30 nests in poor concealment 24 gulls were caught, at the 15 nests in fair concealment 2 gulls were caught, and at the 15 nests in good concealment 2 gulls were caught.

GULL PREDATION ON WATERFOWL BROODS

The methods used to detect predation on ducklings were, weekly waterfowl brood counts to determine the rate of decrease in brood size from one week of age until the young were three-quarters grown and continuous observations on California Gull activities noting all instances of gull predation of young waterfowl.

The waterfowl broods were classified according to their age in weeks up to five weeks of age. Age classifications over five weeks were listed as one-half grown and three-quarters grown. According to my observations, when the young waterfowl had reached three-quarters of their growth they were generally considered safe from gull predation.

No actual instances of gull predation on the Canada Goose young were noted on the study area. A constant brood average of the goslings would indicate that the effect of gull predation on this species was quite negligible (Table 4).

In April 1947, Nelson (1947) observed three California Gulls make

an attack on a newly hatched brood of goslings at the Ogden Bay Bird Refuge, Utah.

A similar instance was noted in April 1948 on the Bear River Migratory Bird Refuge by Smith and Jensen (Flyway Biologists at Bear River Migratory Bird Refuge). A California Gull made an attack on four goslings less than one week old. The gull succeeded in picking up one of the goslings several times, but would drop it back in the water when observers threw clods of mud at the gull to drive it away. In both the above instances the parents were in attendance, but failed to protect the young from the attacking gulls.

Duck species showed a definite decrease in average brood size on the study area. The per cent of decrease on the average duck brood by the time the young were three-quarters grown was: Cinnamon Teal 42.2 per cent, Mallard 34.3 per cent, Pintail 23.3 per cent, Shoveller 42.5 per cent, Redhead 41.4 per cent, and Gadwall 23.5 per cent. The total decrease on the average brood size of all waterfowl species studied was 40 per cent (Table 4). I cannot definitely say just what part of this decrease in average waterfowl brood size may be attributed to gull predation but some loss was observed.

Two instances of California Gulls seizing and killing young ducks were observed during the study. A single week-old young of a female Pintail, apparently her last, was taken by two gulls. A Redhead about 10 days old in a brood of seven was taken by a California Gull.

Apparently only a small percentage of California Gulls acquire the habit of taking young waterfowl.

FOOD HABITS OF THE CALIFORNIA GULL IN RELATION TO PREDATION ON WATERFOWL

The California Gull is a greedy bird and a scavenger, as well as omnivorous in its food habits. If an over-abundance of food is located, the gull will gorge itself until it has difficulty in taking to the air.

Ninety California Gulls were collected—thirty gulls from each study zone. Gravel appeared in 86.7 per cent of the 90 stomachs examined; 77.8 per cent of the stomachs contained material which was considered to be accidentally picked up with other food and was termed debris. The debris included vegetative parts of plants, twine, glass, hair, cinders, and paper.

Insects were found in 35.6 per cent of the stomachs and were readily identified as belonging to the following families: *Cicadidae, Pentatomidae, Notonectidae, Locustidae, Muscidae* (*Calliphoridae*), *Stratio-*

TABLE 4

WATERFOWL BROOD DATA AT FARMINGTON BAY BIRD REFUGE AND NEW STATE GUN CLUB, UTAH, APRIL 25 TO AUGUST 22, 1950

	Age classes													
	1 Week		2 Weeks		3 Weeks		4 Weeks		5 Weeks		½ grown		¾ grown	
Species	Number of broods	Average number per brood	Number of broods	Average number per brood	Number of broods	Average number per brood	Number of broods	Average number per brood	Number of broods	Average number per brood	Number of broods	Average number per brood	Number of broods	Average number per brood
Canada Goose	14	4.9	15	4.9	20	4.7	17	4.5	23	4.6	23	4.5	19	4.5
Cinnamon Teal	36	8.3	9	7.9	5	6.6	11	5.0	15	7.5	6	5.5	20	4.8
Mallard	14	7.0	1	7.0	1	5.0	3	5.7	2	7.0	10	5.1	24	4.6
Pintail	6	6.0	1	5.0	1	6.0	1	9.0	2	5.5	7	4.7	7	4.6
Gadwall	5	9.8	4	7.0	0	0.0	1	6.0	1	9.0	1	7.0	4	7.5
Shoveller	3	8.7	2	7.5	2	7.0	1	6.0	2	4.5	3	3.3	4	5.0
Redhead	35	9.1	14	7.3	7	6.9	5	5.5	1	6.0	5	5.5	7	5.3
Unidentified species	3	9.3	7	8.3	4	5.8	5	7.0	0	0.0	1	7.0	0	0.0
Total	116	8.0	53	6.8	40	5.6	44	5.2	46	5.8	56	4.8	85	4.8

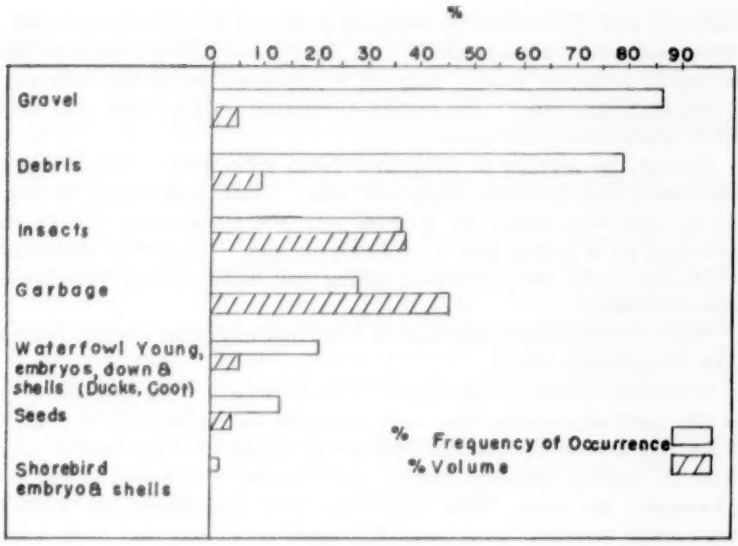

FIGURE 4. Stomach analysis on ninety California Gulls taken from Farmington Bay Bird Refuge and the New State Gun Club, Utah, June 2 to July 14, 1950.

myidae, Carabidae, Dytiscidae, Curculionidae, Tenebrionidae, and *Aeschnidae.*

Garbage was found in 27.8 per cent of the gull stomachs, and included mainly meat (pork and beef), with some bread, salmon, cheese, pork skin, and bone. This would indicate frequent visits to picnic grounds, school yards, camp grounds, and meat packing plants.

Seeds of muskmelon, watermelon, smartweed, cherry, pigweed, and wheat and rye were found in 12.2 per cent of the stomachs examined.

The stomach of one gull contained a Long-billed Curlew (*Numenius americanus*) embryo and egg shells. A young Avocet (*Recurvirostra americana*) about seven days old was taken from another stomach.

The stomachs from 18 of the 90 California Gulls contained waterfowl or parts of waterfowl; one stomach contained a young Coot and egg shells; seven contained wild duck egg shells; five contained wild duck down; one contained four Pintail embryos and egg shells; four contained wild duck egg shells and down. (Figure 4.)

In Zone One, the 30 stomachs were collected from June 23 through July 6, and 23.3 per cent of these stomachs contained waterfowl young, egg shells, and down. In Zone Two, only 6.7 per cent of the stomachs

collected July 12 through 14, when duck nesting was nearly complete, contained wild duck egg shells. In Zone Three, 30 per cent of the stomachs collected June 2 through 9 contained waterfowl embryos, down, and egg shells. The waterfowl nesting on the study area was at its peak during this period.

During the months of May and June, gulls were noted hunting the marsh area for young birds and eggs. These gulls would fly low, six to eight feet above the ground, over the marsh area, always on the alert for a young bird or a clutch of eggs. On several occasions California Gulls were observed killing and eating young blackbirds and shorebirds.

The California Gulls also feed on Utah's cherry crop, Cottam (1935) and Greenhalgh (1952).

Knowlton (1941) states that: "The California Gull undoubtedly is the most appreciated and least molested bird occurring in Utah." This may well be the case, but few people realize that this bird of prey may be eating injurious insects one minute and young ducks or pheasants the next. The California Gull population on Utah's man-made marshes has increased to such an extent that they have become a serious threat to waterfowl production. A rational control program is recommended for the Farmington Bay Bird Refuge and surrounding waterfowl breeding areas that support increasing numbers of California Gulls.

SUMMARY

The adult breeding population of California Gulls increased on the Farmington Bay Bird Refuge and the New State Gun Club, Utah, from about 4,000 to 10,800 during the period 1942–1950. Twenty-eight small islands in the Farmington Bay Bird Refuge were utilized almost entirely by the California Gulls for nesting purposes and little used by other birds.

18.3 per cent of the 2,997 waterfowl eggs in 317 nests were destroyed by California Gulls.

The Pintail had 25.6 per cent of its eggs destroyed, and 57.2 per cent of the Gadwall eggs were destroyed in one of the study zones.

Of the 139 nests under good concealment, only 5.8 per cent were destroyed by California Gulls, 21.8 per cent of the 101 nests under fair concealment and 33.8 per cent of the 77 poorly concealed nests were destroyed by the gull.

To further determine the importance of duck nest concealment, 60 dummy duck nests were constructed. California Gulls were

caught most readily on nests with poor and fair concealment; nests with good concealment were least molested.

It was known that California Gulls preyed on young waterfowl, but the amount of this destruction could not be determined. A forty per cent decrease on the average duck brood was noted by the time the young were three-quarters grown.

The stomachs from 18 of 90 California Gulls contained young waterfowl, embryos, down, and egg shells.

The greatest predation by California Gulls on waterfowl young and eggs occurred from about June 1 to June 25, 1950. At the peak of the waterfowl nesting season (about June 18), it is believed that California Gulls were responsible for destruction of about 30 per cent of the waterfowl eggs and young produced on the study area. By July 14, predation by California Gulls on waterfowl eggs and young was negligible.

A rational control program is recommended for the Farmington Bay Bird Refuge and surrounding waterfowl breeding areas that support increasing numbers of California Gulls.

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OBSERVATIONS ON DISPLAY AND OTHER FORMS OF BEHAVIOR OF CERTAIN ARCTIC BIRDS

BY E. O. HÖHN

THE following observations are based on a stay of nearly three months, May 10 to July 29, 1953, in the Sach's Harbour area of Banks Island (72° N., 125° W.) in the western Canadian Arctic. Distributional and ecological observations made during this period have been published elsewhere (Manning, Höhn, and McPherson, 1956). Manning covered most of Banks Island in 1952 and 1953, but a few observations on behavior made by Manning on Banks Island are included here. Some notes based on my observations in the summer of 1949 in the Mackenzie Delta region are also included.

Although observations on behavior were one of the principal objectives of my stay on Banks Island, I saw disappointingly little bird display. Possible explanations were the unusually late spring and poor weather. There were few sunny days, and even they were very windy. Another possible adverse factor was that since I lived with an eskimo family except when away from Sach's Harbour on short trips, I was forced to adopt their daily routine, which meant staying up till 2:00 A.M. and sleeping till 10:00 A.M. In temperate regions it is well known that bird display is most marked in the early morning, a period which I usually missed. I attempted to make up for this by going out at 2:00 A.M. on June 10 at Cape Kellet and found Ruddy Turnstones still asleep at 2:30 A.M. and Lapland Longspurs not commencing their song till 3:00 A.M. In spite of the rather fragmentary nature of my observations they seem to add a fair amount of new material.

The locality of the observations recorded below is southeastern Banks Island and the year 1953; for observations made elsewhere locality and full date are given.

RED-THROATED LOON (*Gavia stellata*).—Distraction display: A striking form of distraction display was shown on July 26, 1949, by one member of a pair on a small pool on Richard's Island, Mackenzie Delta. While I was searching the shores for a nest, which was not found, both birds swam off stealthily towards the opposite side of the pool. One of them then flew up and making straight for me plunged under water from a height of about 6 feet when a few yards away. It surfaced near its mate and again flew towards me, but this time landed on the surface and swam off, keeping the wing towards me raised and half extended. The usual "ka ka ka kwaoo" call accompanied both these short flights.

BLACK BRANT (*Branta nigricans*).—Aggressive display: A brant, the nest of which was being robbed by a Glaucous Gull, approached the gull swimming with neck extended low along the surface of the water, June 13.

WHITE-FRONTED GOOSE (*Anser albifrons*).—Fear reaction: On August 1, 1949, when our float plane was about to land on one of the lakes at the mouth of the Anderson River where some hundreds of White-fronted Geese nest, one bird flying towards the plane suddenly plunged under water from a height of about 15 feet when it perceived the plane.

LESSER SNOW GOOSE (*Chen hyperborea*).—I saw no Snow Geese on Banks Island until May 18 and passage was not heavy till May 27, yet a visit to the large nesting colony about 36 miles northeast of Sach's Harbour revealed many nests with eggs (clutches up to 5) on May 31. It may be inferred that prenuptial display and mating took place mainly during the spring migration or even in the wintering grounds just before departure. No display was seen in many feeding flocks observed in the Sach's Harbour area. On a visit to the breeding colony May 31 to June 2, a certain amount of mutual display among the members of various pairs was seen, the birds facing one another and waving the raised head about with open bill. One coition or attempted coition was seen. It was conducted so vigorously on the part of the presumed male that at first I took it to be a fight. The (presumed) female lay prone with extended neck flat on the ground. The male repeatedly walked up to the female, grabbed her on the back of the neck with an apparently very violent blow and attempted to mount with flapping wings. After some seconds only he came off and repeated these maneuvers for 5 to 10 minutes. It seemed to me that coition was not achieved in any of his efforts. Other geese were all around at distances of only a few feet and made no attempts to interfere, nevertheless the mating male once chased off another goose.

OLD SQUAW (*Clangula hyemalis*).—The display call of the male has been rendered by various others. I would render it as "Ä äoonwoo" or "ä äoonwä"; the name given to the bird by the Dog-rib indians of Great Slave Lake "ä äonwa" is a good rendering of the call although they also use "a aonlik" as its name.

PACIFIC EIDER (*Somateria mollissima v-nigra*).—The courtship of this species does not seem to have been described. I observed a group in display on July 10 through a telescope. The gestures were as described for the American Eider in Bent (1925), owing to distance accompanying calls could not be made out.

KING EIDER (*Somateria spectabilis*).—Courtship display: W. S. Brooks quoted by Bent (1925) gives a very brief description of the display of this species. The mating call consists as described by Brooks of three not very distinct phrases rendered by him as "urrr urrr urrr" and by Soper (1946) as "how it who who," and which I would render as "brooo rroo rrroo." The note is soft and, as described by Soper (*op. cit.*), dove-like in quality; it is highly reminiscent of the rookoing of the Black Grouse (*Lyrurus tetrix*). I had close views of the display of a group of six males to one female all perched on the floe edge off Cape Kellet on June 10. The female merely repeatedly dipped her head and then flung it up or kept the nearest male off by stretching her head towards it with partly open beak. The males standing on the ice executed a rapid shaking of the whole body, throwing the head up vertically or raising the head more slowly till the bill pointed vertically upwards. At other times the head was rotated horizontally presenting each side view alternately to the female. Most often, with the creamy breast puffed up and the bill resting on it, a sort of gulping forward motion of the head was executed in which the bill was further retracted while the back of the head was raised and moved forward. The display was seen on the water on June 16; again several males were grouped about a single female, several such displaying groups being active simultaneously. Movements of the female were as described above. The males would stand up in the water raising the head then sink down rocking forward, i.e., lowering the breast and raising the tail vertically which brought the white patch at the side of the tail into prominence, the head was simultaneously lowered and brought forward, then retracted into the breast so that the bill was resting on the puffed out breast and the gulping movement above described then followed. In the rocking movement, the projecting point formed by the inner secondaries or tertiaries is at about the center of the rotary movement. This appeared to be the typical display as it was executed in exactly this sequence by all the birds in view. The soft "brooo roo roo" call was continuously heard from many birds throughout my period of observation, and its exact time in the display sequence could not be made out. A similar display was again seen on June 28, and this also included the horizontal rotation of the head. The male display thus appears to consist of at least two independent gestures. 1. The horizontal rotation of the head from side to side. 2. The rearing up of the body with the head thrown upward, followed by a rocking movement, breast down, tail up, and with head retracted onto the breast, and culminating in the gulping motion of the head. The

call is given during one of the phases of the second more complex display.

Behavior of incubating female: Whereas sitting Pacific Eider ducks always flushed when the observer was a few feet from the nest, incubating King Eiders sat very tight. One observed on July 18 actually allowed me to pick her off her 4 eggs.

WILLOW PTARMIGAN (*Lagopus lagopus*).—Aggressive behavior in defence of the young: On July 15, 1952, Manning and his companion came across a pair with young not over three days old. When the young were picked up, the female actually struck the observers with her wings. I made a similar observation on the closely related (considered by some conspecific) Red Grouse (*Lagopus scoticus*) in England, June 1, 1939. A female, when her young were approached by a young lady who was with me, ran up to the intruder's feet, with outspread tail and laterally extended wings, clucking and moving with extremely rapid short steps, giving the impression of rolling along rather than walking. The display was fully effective in inspiring fear in the disturber who ran to me shrieking for protection. It is probably equally effective against animal predators.

ROCK PTARMIGAN (*Lagopus mutus*).—A presumed male when flushed May 11 landed by another Rock Ptarmigan and walked toward it with tail erect and wings drooped, croaking as it did so. I collected the second, passive bird and found it to be a male. As the birds can probably distinguish the sex of others in the spring this observation suggests that as in some of the grouse, e.g., *Lyrurus tetrix* (Höhn, 1953) the strutting display is directed both at rival males and females.

On May 31, when the female of a pair of Rock Ptarmigan was shot, the male, who was about ten yards away, approached the corpse, displaying with raised and fanned out tail and drooping wings.

On June 6, I was able to repeat this observation as a deliberate experiment shooting the female of a pair. As soon as the female fell prone the male ran up and displayed as described above and croaked. I then placed the corpse in a more life-like but prone position and retired, but the male bird showed no further interest. These two observations are, I think, readily explained by the surmise that the sudden assumption of a prone posture by the female, the position in which in most birds the female indicates a willingness to mate, acts as a releaser to prenuptial display and, if the female were alive, coition. A parallel is offered by the repeated mountings of stuffed prone females by male Black Grouse as described by Lack (1939).

An experiment of the above type with Willow Ptarmigan was

unsuccessful. On June 5, I flushed first a male then the female which I shot on the wing and finally had to run down as it was only wounded. I left the female's corpse lying down and watched the male from a distance. He approached the corpse but only to within thirty yards and did not display. The failure of this experiment was probably due to the fact that the female was shot on the wing, while the Rock Ptarmigan females were walking when shot and their collapse in death would look much more like a natural pronation of the bird.

LITTLE BROWN CRANE (*Grus canadensis*).—Features of courtship display were seen on several occasions. Of three cranes seen on May 15, one was standing behind another one and trumpeting with neck retracted over the back and with the head pointing up vertically. On May 27 one bird of a pair followed his mate in a series of hops and stood behind his partner with head and neck stretched forward and the wings kept extended. On June 2, I fired at one of a feeding pair with a 22 rifle. The bird was not hit but immediately leaped up, flew over to the other bird and landed behind it pointing the head forward and vertically downward. Then both birds alternately leaped up 3 to 4 feet with head raised several times, trumpeting the while. After this they resumed feeding, a second shot stimulated a second period of this alternate "flutter jumping."

SEMIPALMATED PLOVER (*Charadrius semipalmatus*).—Display flight: This was seen on several occasions in June. The bird flew with abnormally slow, deep wing beats calling "too wät wät wät wät."

AMERICAN GOLDEN PLOVER (*Pluvialis dominica*).—Display flight: Wing motion was as noted above for the Semipalmated Plover. The song was "toojick toojick toojick," and is no doubt the basis of the Eskimo name "tulik."

Witherby et al., (1943) point out that the notes of this species on the breeding ground have not apparently been recorded, the note here recorded obviously differs from the "peer er wee" display flight note recorded by these authors for the conspecific Asiatic Golden Plover. Distraction display seen on July 11 consisted of crouching and waving both abducted wings while calling plaintively. The call accompanying this was recorded (1949, Mackenzie Delta) as "te tee duiee."

BLACK-BELLIED PLOVER (*Squatarola squatarola*).—A nest found on July 16 with 2 eggs, had three eggs on July 17, and four on July 18. There is only one published record of the incubation period, Brandt quoted by Bent (1929) who records it as 23 days. In the nest referred to above only one egg hatched 24 days from completion of the clutch. Only the more brightly colored bird of the pair, presumably the male,

was seen at the nest between the period of completion of clutch and hatching and appears to have been solely responsible for incubation, though from the observations of others it is clear that in most cases both sexes incubate.

Distraction display consisted of running with fanned and depressed tail and crouching with extended head and neck and waving of the wings, which were held arched over the back.

A number of experiments were made on the presumed male of the pair owning the above nest, the bird being observed through a very small hole in a tent set up as an observation blind. The results of these experiments may be summarized briefly as follows:

Retrieving of eggs placed on rim of nest scrape.—One egg so placed was apparently rolled into the nest by the bird, but on checking I found the egg had not actually been moved. When three eggs were placed on the rim, the bird rolled back two but left one on the rim and returned to incubate the rest. When two eggs were placed on the rim, only one was rolled back. Two eggs moved six inches from the center of the nest elicited attempts to roll them in with the bill, the bird rising partly on its legs to reach them, but it finally settled to incubate the remaining eggs without having actually moved those displaced. The imperfections of the egg retrieving reaction are obvious. It would be interesting to know how far eggs may be displaced from the nest and still elicit attempts to roll them back. Further experiments might also decide whether it is the sight of the diminished clutch or that of the displaced eggs which acts as the main stimulus to rolling-back attempts.

When the eggs were lightly covered with grass the bird on its return pecked at the grass once or twice but without removing any, then walked off, returned pecking in vain, again walked off, and repeated this for the ten minutes I allowed this experiment to run. The covered eggs clearly presented a problem the bird was unable to solve. This is in contrast with the Ringed Plover which succeeded in exposing eggs covered with sand (Laven, 1949). The difference in behavior of the two species in this test is possibly due to the fact that nests of Ringed Plovers on sand dunes are quite likely to be sand covered at times by wind action, whereas covering of the eggs as a natural accident is extremely unlikely in the Black-bellied Plover so that there is nothing to favor the evolution of a reaction to deal with this situation.

Reactions to dead birds.—I placed the corpse of a female Black-bellied Plover over the eggs in as life-like an imitation of an incubating bird as possible. The nest owner on his return first eyed the dead

bird from about two feet off then walked up and down beside it. Finally he touched the dead bird repeatedly with the bill between the wings and tail as if trying to get at the eggs. Being unsuccessful in this also, he settled down as if to brood in a nearby depression. Apparently the corpse was treated as though it were the bird's mate taking a share in incubation. After flushing the bird, the corpse was placed prone with outstretched neck on the ground one and one half feet from the nest to see whether it would elicit display or attempts at mating on the part of the male. The bird was slower than usual in returning to the nest but finally settled on the eggs paying no attention to the corpse.

Next day a dead Pomarine Jaeger was placed in an upright position with closed wings three feet from the nest. The Plover walked towards the Jaeger with wings drooped below the level of the tail and held close to the body, calling "pee pee" repeatedly it flew low over the Jaeger yelping but never actually touching it, at times it walked to within three feet of it. The Plover would obviously not incubate under these conditions and after 10 minutes the Jaeger was removed and the bird returned very promptly to the eggs. Next the Jaeger was laid on the ground on its side; now the Plover walked about peeping with wings drooped but never engaged in the mobbing flights seen before, at times it almost went to the eggs but always ran off again.

Next I replaced the Jaeger with my brown parka rolled into a bundle resembling the Jaeger and matching closely in color the dark plumaged areas of the Jaeger. The Plover returned, walked round three sides of the parka and within three minutes had settled on the eggs. The Jaeger even when laid on the ground was clearly distinguished from the parka.

Experiments to elucidate components of the "nest complex" i.e., the releasing stimulus complex for incubation. The clutch of eggs was moved one foot from the nest scrape and four roughly egg-shaped stones placed in the nest. On its return, the bird first stood over the scrape but then went to the eggs, settled down, and recommenced incubation. However, the result was quite different when the clutch was moved three feet from the nest scrape. On the first test (the scrape being left empty) the bird first returned to the scrape and stood over it making one or two pecking movements. Then it went to stand over the eggs and appeared to arrange them with its bill. Then it returned to the empty nest scrape, did some apparent arranging with its bill there and settled as if to incubate. However, as soon as I looked up again after recording this, the bird was seen

standing about ten feet off the nest. It returned, stood over the scrape, then over the eggs, but finally walked off calling at times and settled down to preen, ten feet away from the scrape. After allowing the bird a short spell of incubation with the eggs replaced in the scrape, the eggs were again placed three feet from the nest and four stones were laid in the scrape. The bird first preened for two to three minutes, then came to stand over the eggs but did not settle. It then went to the scrape, settled down, but almost immediately rose again and walked off, possibly disturbed by the calling of some Sabine Gulls. It stopped about ten feet from the nest, preening for about six minutes and finally appeared to go to sleep. Clearly in a displacement of the clutch by only one foot, the new position of the eggs is readily accepted, a three-foot displacement presented an apparently insoluble problem with the nest scrape exerting a greater pull than the sight of the eggs.

This suggested that the immediate surroundings of the scrape were an important component of the nest complex. Accordingly, two days later I altered the area surrounding the nest for a distance of about three feet all around by placing within this perimeter all at once diverse objects available nearby, such as a 5-inch length of caribou spine, a small board, three small rocks, a clump of purple saxifrage, a one and one half foot long pellet like object, some strips of bark and a torn-up creeping willow plant. This obviously effectively altered the immediate nest environment, but the bird returned and settled to stay on the eggs within five minutes. This suggested that the sight of the scrape was perhaps an important component of the situation. Accordingly, on disturbing the bird again, I covered the scrape completely with the moss-like basal clumps of a small flowering plant. The eggs were placed on top of this pad, the previously used surrounding objects were rearranged, and soil was added. The bird returned, did more than the usual arranging of the eggs with the bill while crouched over them, then settled to brood for two minutes, then stood up again, rearranged the eggs, sat down again and this time stayed.

It can be concluded from this that neither the sight of the nest scrape nor its immediate surroundings play an essential role. The eggs are obviously important as they are accepted one foot away from the nest, yet at a three foot displacement the nest site and the eggs each act as stimuli, the nest being apparently the stronger of the two. Since the scrape itself may be hidden and its immediate surroundings altered without disturbing the birds incubation response, it appears to me that the feature of the nest site which acts as a stimu-

lus is the view from it of objects in the middle or far distance. It would almost appear as though the bird had taken (of course unconsciously) certain bearings from the nest which are hardly changed by a one-foot displacement of the clutch but are changed by a displacement of three feet. Further experiments for which I had neither the time nor the facilities would be needed to test this experimentally. A comparison of these results with those of similar experiments carried out in the Herring Gull (Tinbergen, 1953) is interesting. Herring Gulls apparently sit down in the *empty* nest when the clutch is placed only one foot from it. Also, in nest site recognition, gulls nesting in a more or less featureless environment (sandy shore) do use landmarks such as boxes or barrels washed up by the waves, which were apparently (though this point is not clearly stated) in the near vicinity of the nest.

WHITE-RUMPED SANDPIPER (*Erolia fuscicollis*).—The flight song of this species is described by Soper (1946) who also described its nest-distraction behavior (1928); the ground display does not seem to have been described. On July 1, I saw what appears to have been a fragment of the ground display. A single bird was seen standing with one wing expanded and raised almost vertically, the lower surface being faced forwards. Mr. T. H. Manning informs me (*in litt.*) that he has fairly frequently seen birds of this species raise a wing.

BAIRD'S SANDPIPER (*Erolia bairdii*).—The ground display of this species has been described only by W. S. Brooks, (quoted in Bent, 1927). I observed a somewhat different form of it on June 17. One bird, presumably the female, was standing still; the other was running back and forth from the side to the front of the female in small semicircles, holding the tail fanned out and depressed and one wing raised vertically. As the bird moved, it alternated the wing which was raised. My impression is that it was the wing on the side towards the female which was raised, but my notes made at the time do not mention this. This display was performed in silence. The display seen by Brooks followed after the male alighted, both wings were raised, and the primaries were slowly raised and lowered while the forearm remained perpendicular. It is probable that this display with both wings precedes the runs described above, which probably constitute the actual prenuptial display. On this occasion however, the male took wing and gave its flight song using a rapid but shallow flickering sort of wing beat and uttering a "purring" note, no doubt the same note as that described as a reeling trill suggestive of a cricket or cricket frog by Wynne-Edwards (1952).

The nest distraction behavior from nest or young is described

by Brooks (quoted in Bent, 1927) as "broken wing trick," and Wynne-Edwards (1952) as trembling with arched wings while screeching. I saw one of a pair on July 10, which, calling anxiously, would fly low with trailing legs, and at times when alighting did a typical "rodent run" with fanned out and depressed tail.

SEMIPALMATED SANDPIPER (*Ereunetes pusillus*).—A number of descriptions of the flight song are given by Bent (1927); more recently Soper (1946) has also described it. A pair observed July 26, 1949, on Richard's Island, Mackenzie Delta, which already had at least one downy young, called "tree" and in flight uttered a swallow-like twittering which I rendered as "djû djû djû djû," etc., or, "wioo wioo wioo." This is no doubt the trill described by several other observers. One observed on July 29, 1949, however, used both a different song flight and call, whereas the wing beats in the above description and as observed by others were short and rapid, this bird used slow deep wing beats as are characteristic in the song flights of plovers and called "di jip di jip di jip," etc.

BUFF-BREASTED SANDPIPER (*Tryngites subruficollis*).—Rowan (1927) has described several display postures seen in spring migrants of this species in Alberta, consisting essentially of raising one wing (most frequently seen) or both. On Banks Island, I only saw these sandpipers on three occasions, and only the display with both wings extended was seen. On June 27, one bird of a party of eight would repeatedly stand very upright, back to the wind, with both wings extended and somewhat raised with the underside of the wing facing directly forward. No calls accompanied this display. There was also some "fighting" consisting of threat attacks with the bill and chasing on the ground. On June 1, the same display was seen again.

SANDERLING (*Crocethia alba*).—On June 10, at Cape Kellet a number of Sanderlings feeding on the ground were grouped in pairs. The apparent males (brighter and plumage with more pronounced breast coloration) of three pairs walked with fluffed-up plumage thus looking rather humpbacked as they went about busily pecking, followed by the females which were not fluffed up but uttered frequent high pitched squeaks. At times, the males flew up and, cruising about fairly low with very rapid wing beats, called "twa twa twa twa" also giving at times the rather low-pitched purr noted below. When the males alighted, the females generally ran up to them but were not apparently noticed by the males.

The song flight is described as being accompanied by a loud strident churring rendered "trr trrr trrr" by H. Walter and by C. T. Dalgety and J. H. McNeile (all quoted by Witherby *et al.*, 1943) as like a grasshopper's trill. I heard the same note on June 27 and described

it as a purring somewhat reminiscent of the ring of an alarm clock and changing in pitch at times. This was uttered while in flight about 60 yards above the ground (much higher than recorded by others), the bird using rapid, bat-like wing beats alternating with gliding and wheeling about.

The distraction display from the nest with eggs is described by Manniche quoted in Bent (1927). On July 23, I observed it in a bird which had two downy young, it ran in a skulking fashion calling "tcha tcha tcha" and carrying the tail spread and depressed. As there is some disagreement as to the participation of the two sexes in incubation, Manniche (*op. cit.*) stating that it is restricted to the female while other observers record males shot from eggs, it is worth recording that a male showing the above type of distraction behavior shot on July 15, had well-marked incubation patches.

SNOWY OWL (*Nyctea scandiaca*).—While this species is sometimes quite aggressive when the nesting area is disturbed (Sutton, 1932) the birds are at other times quite shy, withdrawing while people are about the nest as noted by Soper (1928). This was the case with the pair owning a nest with three eggs found on June 29. At other times a striking distraction display was put on by owls whose nests I was unable to find. Only one instance of this particular type of display seems to have been recorded previously (Sutton, 1932). My observations of it are: July 2, a Snowy Owl flew about calling "quă quă quă" then perched 40 yards from me lying flat on the ground facing me with the wings partly extended out from the side and occasionally waving one wing, on closer approach it took off without further display. The same crouching display was shown by one member of another pair on July 18, but on this occasion the bird waved both wings. When facing the observer in this crouch the owls present a curious resemblance to a baby seal. In Sutton's observation of this crouch the performing female gave a whining call, but in my observations the birds were silent. A similar display was seen by Mr. Manning in July further north on Banks Island.

GLAUCOUS GULL (*Larus hyperboreus*).—Witherby *et al.* (1943) state that no proper comparison of the notes of this with those of allied species has been made. It is therefore worth noting that I recorded the calls at a nesting colony (Richards Island, Mackenzie Delta, July 26, 1949) as exactly like those of the Herring Gull (*Larus argentatus*) the common call was "kiă kiă kiă," etc., but there was also "gah gah gah gah" apparently expressing anxiety at disturbance of the downy young, as in the Herring Gull. While Salomonsen (1950) records the calls of this species as indistinguishable from those of the Great Black-backed Gull (*Larus marinus*), Wynne-Edwards, 1952,

notes (without further details) that the voice and calls resemble those of the Herring Gull much more closely than those of the Great Black-backed Gull.

LAPLAND LONGSPUR (*Calcarius lapponicus*).—The breeding behavior of this species has recently been studied (Grinnell, 1944) but post-breeding season song does not appear to have been recorded. I noted it in several individuals, August 20, 1949, Richards Island, Mackenzie Delta, in the early morning, and again on August 2 and 6 at Holman Island, Victoria Island, in 1953. In all cases it was given not on the wing like the spring song but from a perch and was shorter and weaker. The spring song ceased in southeastern Banks Island about July 8.

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Department of Physiology and Pharmacology, University of Alberta, Edmonton, Alberta, Canada, August 10, 1954.

BIRD HABITATS ON MIYAKE JIMA, JAPAN. (*Above*) Habitat of the Island Grasshopper Warbler (*Locustella ochotensis pleskei*) at Ma Point, May, 1953. (*Below*) Nesting site of the Japanese Murrelet (*Synthliboramphus wumisuzume*). Sanbondake Reef, May 26, 1953. Photographs by H. E. McClure.

THE BIRDS OF MIYAKE JIMA, JAPAN

BY JACK T. MOYER

AMONG the most interesting areas for ornithological research in Japan are the Izu Islands. Beginning at Oshima Island, a mere fourteen miles from the Izu Peninsula at the entrance to Sagami Bay, the Izus stretch southward to the tiny island of Tori Shima; a distance of nearly 250 miles. Included in the chain are, in addition to those already named, To Shima, Nii Jima, Kozu Shima, Miyake Jima, Mikura Jima, Hachijo Jima, Aoga Shima, and several tiny islands and reefs. All are part of a volcanic belt stretching from famous Mount Fuji, on the island of Honshu, through the Bonins and the Volcano Islands to the Marianas Islands.

The avifauna of the Izu Islands includes a number of endemic species and subspecies, including *Phylloscopus ijimae, Zosterops japonica stejnegeri, Troglodytes troglodytes mosukei, Parus varius namiyei* (To Shima, Nii Jima, Kozu Shima), *P. v. owstoni* (Miyake Jima, Mikura Jima, Hachijo Jima), and *Ixos amaurotis matchiae* (Hachijo Jima).

The similarities between the avifaunas of the Izu Islands and the island of Yaku Shima off the southern coast of Kyushu are striking. The interesting Seven Islands Thrush (*Turdus celaenops*) is found only in these two localities (*T. c. celaenops* in the Izus and *T. c. yakushimensis* on Yaku Shima); and populations of the Pigmy Woodpecker (*Dendrocopos kizuki matsudairai*) and Japanese Robin (*Erithacus akahige tanensis*) of the Izus are both indistinguishable from the corresponding Yaku Shima forms.

Other particularly interesting birds of the Izu Island birds are *Otus asio*, which is indistinguishable from *O. a. pryeri* of the Ryukyus, and *Synthliboramphus wumisuzume*. The latter was once fairly common in the Izus and, to a lesser degree, in the Korean straits; but as there are no recent records from the Sea of Japan, the Izu Island population may be the last to survive.

Unfortunately, transportation to and from the various islands is not easily available, and as a result only a limited amount of field work has been accomplished. Oshima, because of its proximity to the Honshu coast, and Hachijo Jima, a former home of the noted Japanese ornithologist, Tokutaro Momiyama, are best known. Miyake Jima, the third largest of the Izu Islands, has been visited by various ornithologists, but much remains to be learned about the status of birds there. It is hoped that this paper, a result of my six journeys to Miyake Jima, will be of some value to students of

Japanese birds, and that it will stimulate further field work in the Izu Islands.

My journeys to Miyake Jima were made between July, 1952, and April, 1954, as follows: July 24 and 25, 1952; April 5, 6, and 7, 1953; April 12, 13, and 14, 1953; May 23 to June 3, 1953; August 22 to September 1, 1953; and April 6 to 16, 1954. A total of forty-two days was spent on the island, all in the spring and summer seasons. Extensive field work was conducted on all but the last two trips, when only limited time was available for ornithology.

Miyake Jima is an active volcano which last erupted in 1940. The island is nearly five miles in diameter and is dominated by 2600-foot Mount Oyama. Situated at Latitude 34° 5′ N and Longitude 139° 30′ E and bathed by the warm Kuroshio (Japan Current), Miyake is blessed with a subtropical climate. Forests of live oaks, live beeches, camphors, and cryptomeria, and extensive camelia orchards blanket the island. Several volcanic craters of varying age account for a variety of ecological niches. Two of these are the settings for Lake Tairo and Shirei Pond, both of which are surrounded by magnificent virgin, subtropical forests. A third crater forms an extensive, forested amphitheater southeast of Tsubota Mura. The crater of the 1940 eruption, about two miles north of Miike Beach, is surrounded by barren slopes of volcanic ash, as is the main crater at the summit of Mount Oyama. Two other craters between Tsubota Mura and Kamitsuki Mura are gradually being reclaimed by vegetation, largely Black Pine (*Pinus thunbergii*).

The Miyake coastline is dominated by black boulder-strewn shores, frequent perpendicular cliffs, and an occasional beach of black volcanic sand, the most extensive of which is Miike Beach.

The island is populated by some 7,000 Japanese, most of whom are engaged in the fishing for and preparation of "tengusa" (*Gelidium cartilagineum*), a red seaweed from which agar is produced. Camelia oil, dairy products, and charcoal are other important resources.

Most of my field work was limited to the area between the 1940 crater, south and west to Ako Mura, with by far the greatest amount of time being spent between Tsubota Mura and Lake Tairo (see Figure 1). Limited observations were made in July, 1952 and May, 1953 in the vicinity of Igaya Mura; and occasional surveys of the lower slopes of Mount Oyama were conducted. Three boat trips were taken to Sanbondake, a rocky reef five miles west of Miyake Jima.

I am indebted to a great many individuals for assisting me in this study. Ornithologist friends who accompanied me on various trips

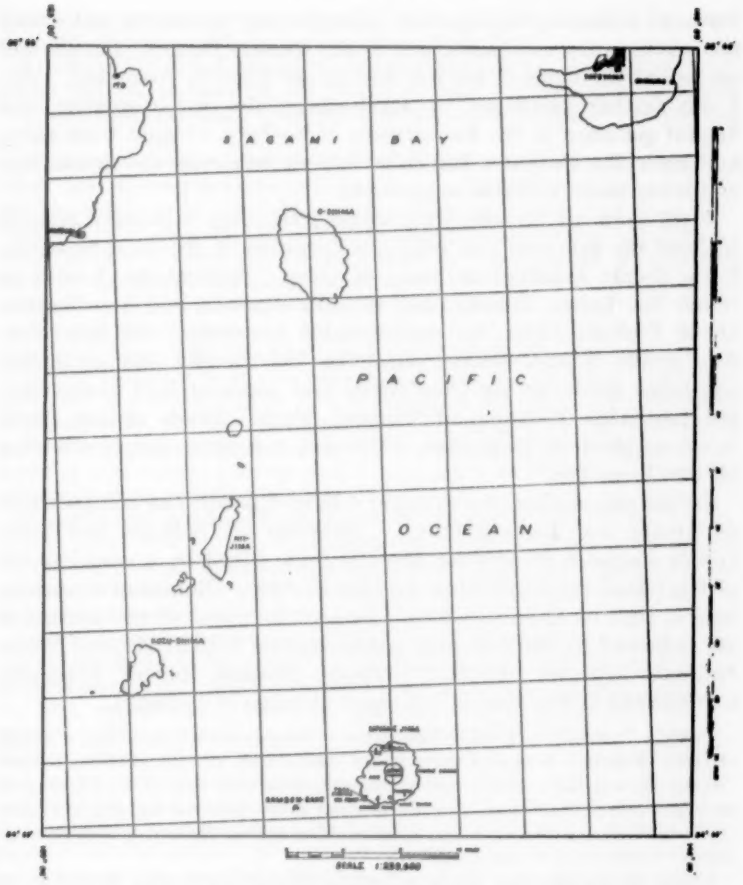

FIGURE 1. The Izu Islands from the mouth of Sagami Bay to Miyake Jima.

and generously allowed me access to their notes and suggestions are Dr. Robert Smith, USAF; Dr. H. Elliott McClure, 406th Medical General Laboratory, Japan; Mr. Tatsuo Udagawa, Forest Experiment Station, Asakawa, Japan; and Mr. Hiroyuki Morioka, Kyoto University. Dr. McClure also contributed several fine photographs. Other companions, Mr. Charles Fletcher, Hyattsville, Maryland, and Dr. Van Philpot, University of Wisconsin, are thanked for their willing assistance in collecting specimens and in general field observations. I am grateful to Mr. Herbert Deignan, of the United States

National Museum, who checked several of my specimens and added many interesting comments; and to Mr. Chester Fennell, who allowed me use of the notes of his trip to Miyake Jima in December, 1952. I am further privileged to acknowledge the encouragement and helpful guidance of the Department of Zoology, Colgate University, and especially Professor Raymond Myers, who read the manuscript and made many valuable suggestions.

Field work on Miyake Jima would have been extremely difficult without the generous and willing coöperation of the local residents. I am deeply indebted to many of them. Particularly, I wish to thank Dr. Tatsuo Tanaka, Mr. Gonichi Yamada, and Mr. Nagata, all of Tsubota Mura, for unforgettable hospitality and assistance. And finally I shall always remember the friendly and invaluable assistance given by my close friend and constant field companion, the late Akio Tsukuba, of Tsubota Mura. Akio's sudden death in an accident in November, 1954, was a tragedy deeply affecting all who knew him.

In the preparation of this paper I have followed the nomenclature of Austin and Kuroda (1953). Asterisks (*) indicate first sight and/or specimen records for Miyake Jima, based on a complete list of Izu Island birds published by Shirai (1952). Botanical nomenclature is that of Makino (1940). Present locations of my specimens are indicated by the following abbreviations: USNM (United States National Museum), CNHM (Chicago Natural History Museum), and UMMZ (University of Michigan Museum of Zoology).

Puffinus leucomelas. Streaked Shearwater. Abundant over the ocean a couple of miles off-shore. A typical entry in my notes, April 7, 1953, reads as follows: "About one mile from shore, where the currents from both sides of the island meet, we began to see shearwaters. For the next few miles, hundreds and hundreds were observed skimming over the water, passing and re-passing the boat in such numbers that an actual count was impossible."

During the ten-mile boat trip from Tsubota Mura to Sanbondake Reef, May 26, 1953, shearwaters were constantly in sight, and more than 1000 were counted. A male was collected by hand from a crevice in the rocks on Sanbondake, and three more males were shot on the return trip to Miyake. (CNHM, three males; UMMZ, four skeletons.)

**Puffinus griseus*. Sooty Shearwater. I saw two with Streaked Shearwaters between Sanbondake Reef and Miyake, May 26, 1953.

**Sula leucogaster*. Brown Booby. One flew past our boat as we approached Sanbondake Reef, April 5, 1953.

Phalacrocorax capillatus. Temminck's Cormorant. Common during April, 1953 and 1954. From thirty to forty birds roosted on a cliff near Miike Beach both years, and an equally large roost was found near Toga Shrine in April, 1954, from which an immature and three adults were collected. Sanbondake Reef provided another large roost, and numerous individuals were frequently seen resting

on large boulders along the Miyake coast. Cormorants were sometimes observed, and an immature was collected, at Lake Tairo, April, 1953.

By May nearly all had departed for their northern breeding grounds, and in the twelve days of observation in late May, 1953, only four cormorants were seen. The large roost near Miike Beach had been abandoned to swifts. (CNHM, two skins.)

**Phalacrocorax pelagicus pelagicus*. Pelagic Shag. Shirai's (1952) list of Izu Island birds records this species only from Oshima and Shikine islands, and Austin and Kuroda (1953) list it as occurring "sporadically to the latitude of Chiba." In April, 1954, Dr. Tatsuo Tanaka, of Tsubota, showed me an immature of this species which had been collected near Kamitsuki Mura by a local hunter. I collected an adult and an immature at the cormorant roost near Toga Shrine, April 20, 1954. Both specimens are now in the collection of Mr. H. Morioka.

**Butorides striatus amurensis*. Mangrove Heron. I collected an adult male at Lake Tairo, May 25, 1953, as it fed with five juvenile Black-crowned Night Herons in shallow water near shore. I observed single Mangrove Herons at Lake Tairo twice, May 26 and again May 29. One was seen exploring the rocky coastline north of Tsubota Mura, May 29, 1953. It would follow the waves as they receded, taking to the air as new waves crashed in, only to repeat the act again and again, moving each time several yards down the coast in a manner reminiscent of the Reef Egret (*Demigretta sacra*). (CNHM, one skin.)

**Egretta garzetta garzetta*. Snowy Egret. Dr. McClure collected a Snowy Egret at Lake Tairo, June 3, 1953. This appears to be the only record of this species from the Izu Islands, which is not surprising since the topography of the islands does not favor waders. Early in the morning, May 31, 1953, I saw a white egret of undetermined species flying northward, high over Miike Beach.

**Nycticorax nycticorax nycticorax*. Black-crowned Night Heron. At least one pair of night herons nested successfully near Lake Tairo in 1953. On two different occasions on May 25, I flushed a flock of five immatures from the shore of the lake. The birds were not yet accomplished flyers and made their escape not without difficulty. While collecting at Lake Tairo, May 29, McClure and I frequently observed immature herons in the dense forest surrounding the lake, but owing to their wariness and the density of the foliage, we could not accurately estimate their numbers. On June 3, I shot a fully-grown immature as it flew from a camelia tree in an orchard on the ridge above Lake Tairo. Adults were collected April 5, 1953; April 6, 1953 (Morioka); and May 30, 1953 (McClure), all at Lake Tairo. However, not all records came from Lake Tairo. Three or four night herons passed noisily overhead at dusk, May 27, as I hunted woodcock two miles north of Miike Beach.

Gorsakius goisagi. Japanese Bittern. Not uncommon on Miyake, where it is called "Baka Dori" (fool bird), a name resulting from its weird call. I often heard it calling shortly after dusk, however obtaining a look at this secretive species is not an easy task. I saw single birds at Lake Tairo, May 29 and May 30, 1953, but both disappeared into the deep forest before I could get within gun range. They are less wary at night, and I once was able to stalk in the darkness to a point directly under one as it called from a high branch. Its call, at close range, was typically bittern, beginning with a quiet pumping followed by a much louder "croaking." The initial pumping is inaudible from more than forty or fifty yards, and the "low, simple croaking" described by Austin and Kuroda (1953) is merely the climax of the call.

Schoolboys brought three nestlings to my room in Igaya Mura, July 24, 1952, and the following day they took me to the nest. It consisted of a rather sloppy

platform of twigs, placed far out on a branch of a small deciduous tree which grew out from the bank of a narrow gully. A shallow stream flowed through the heavily forested gully, and the nest-tree grew out at such an angle that the nest was directly over the stream at a height of some 15 feet.

Yamashina's late egg dates from Miyake Jima (July 10, 1934) and Mikura Jima (July 20, 1934), suggested as possible second-broods by Austin and Kuroda (1953), are particularly interesting when compared to the three Igaya Mura nestlings, which we estimated to be approximately twelve days old, July 24, 1952.

Milvus migrans. Black-eared Kites were a familiar sight soaring low over the crowded villages, searching the rocky shores, or hanging suspended on the monsoon winds, high over the island. In May, 1953, three pairs occupied the area between Miike Beach and Lake Tairo. The two birds at Miike Beach were particularly tame, often passing quite low over the *tengusa* fishermen. Once I saw one of them drop into a farm yard to pick up an unidentified object. A dead tree on the ridge above the beach was their favorite roosting place, and both birds spent many hours there daily.

Kites are known as great gatherers of trash paper, old shoes, rags, etc., with which they line their nests. Near Ako Mura, May 25, 1953, I saw a kite drop to pick up a large piece of paper, which it carried away toward some unknown destination.

Buteo buteo burmanicus. Eurasian Buzzard. A fairly common winter visitor on Miyake Jima. Chester Fennell, who spent two weeks collecting on the island in December, 1952, saw buzzards daily, singly or two or three at a time, soaring over the island. He collected a male. I found the situation much the same on Oshima in January, 1953, where I collected one buzzard and frequently observed four others along a three-mile strip of coast.

Buzzards were much less common on Miyake in April, the last being observed April 12, 1953, behind the Tsubota High School. I worked the same area carefully, April 13 and 14, and saw none. Nor were any observed during the May, July, or August trips. It is possible that some may have remained throughout the breeding season, but if such were the case, they were unusually elusive. In this respect my notes of April 5, 1953, are interesting. "Just after sunset, as we approached Lake Tairo, we saw a *Buteo* (A) fly across a field and land in a pine near the lake. After a moment, another (B) swept in, landing in an oak in the middle of the field. (A) then flew from its perch, landing in the oak, directly under (B), who was noticeably smaller, and may have been the male. I expected to see them mate, but (A) took off followed by (B), and they began soaring in wide circles over the lake, (B) making occasional feints and short dives at (A). Soon they disappeared against the dark background of the ridge."

Butastur indicus. Frog Hawk. A common and well-known summer resident on Miyake Jima, where it is erroneously called "Hayabusa," the Japanese name for the Peregrine Falcon. It is easy to determine the exact arrival date of Frog Hawks from their winter quarters, since they call almost continously every morning from their arrival until after the eggs are in the nest. My earliest Miyake record came April 12, 1953, when one was heard calling. Their presence was further announced the following day when a bulbul was seen giving an excellent *Butastur* imitation. Shortly after, a Frog Hawk flew over the forest and thereafter, two or three were seen daily. They are rather secretive breeders and, were it not for their morning calling, they would seldom be observed. The call, which is often given as the bird soars two or three hundred feet over the tree-tops, is usually described as a plaintive, cat-like meow. Actually it can easily be compared to the cry of the North American Broad-winged Hawk (*Buteo platypterus*). The difference is that the Asiatic bird's

call is slightly louder and more harsh, and there is a slight break or pause in the cry, unlike the smooth, unbroken whistle of the Broad-winged Hawk. Their respective calls can be described as follows: *Butastur indicus*, "Whick-aweee"; *Buteo platypterus*, "Peeeaweee."

The breeding territory of the Frog Hawk can be quickly located in April and early May by the cries of the courting birds. During incubation, the calling is much less frequent, but it can still be heard. Guided by such calling, I was able, with the aid of several Tsubota schoolboys, to locate six definite territories and three nests in May, 1953.

Nests are difficult to find owing to the secretive, elusive behavior of the adults when enemies enter their territory. Unlike many of the *Buteos*, who scream defiantly whenever anyone approaches the nesting site, the male *Butastur* retires quietly into the dense foliage and the incubating female lies flat on the nest, invisible from the ground. When the nest is discovered and the tree climbed, the birds usually defend boldly. Both scream continuously and often a series of diving attacks is made at the intruder. I have climbed to six *Butastur* nests and have never been struck, although one particularly aggressive female at a nest near Tokyo (the sex had been determined from earlier observations) brushed my head with her wings as she swept by.

My first Miyake Jima nest was found May 23, 1953, in a forested gully about one mile from Igaya Mura. The nest was placed in the fork of a camphor tree (*Cinnamomum japonicum*) some twenty-five feet over the floor of the gully and about the same distance from the base of the tree, which grew out from the side of the gully. It was sixteen inches in diameter, made of sticks, and lined with old sprigs of cryptomeria, but there was no fresh lining. After the eggs hatch, Frog Hawks line their nests with fresh leaves. I made daily observations of a nest near Tokyo in 1952, and found fresh leaves of a variety of deciduous and coniferous trees added to the nest daily for the first eight days after the eggs hatched, and every two or three days from the ninth day until the young left the nest on the thirty-sixth day.

The Igaya Mura female was incubating when we arrived, but left the nest to defend when we started climbing. The male made one screaming pass over our heads but then disappeared into the forest. I collected the female and the set of three well-incubated eggs. The iris and cere of the female were a very brilliant yellow and the legs only slightly paler. This is a condition clearly associated with breeding and is not found to such a marked degree in specimens taken in late summer and during migration. The Igaya specimen was very fat and her crop contained two lizards and a grasshopper. Another lizard was in her throat.

The next nest was found the following day in a live oak (*Shiia sieboldii*) in a small grove of trees near Miike Beach. It was placed far out on a branch, forty-five feet over the ground, and was identical in structure to the Igaya nest. It was fourteen inches in diameter and contained no fresh lining. The adult birds made no attempt to defend the nest, even when we climbed, but when two Thick-billed Crows passed over the territory, the male followed in hot pursuit. Later as we watched from concealment, the male flew over our heads to the nest with a lizard in his mouth, which he fed to the incubating female.

I collected the set of two eggs, which, like the Igaya Mura clutch, were well-incubated. As I climbed to the nest, the adults, instead of defending, flew to a nearby hillside where the male mounted the female, who made no effort to resist; a good example of what students of bird behavior call "displacement activity."

The third nest, found May 26, 1953, was placed twenty feet from the ground in

a camphor (*Machilus thunbergii*). About ten yards from the nest, in another camphor, was an old, broken nest which schoolboys said had been used by Frog Hawks the previous year.

I saw two Frog Hawks near Igaya Mura, July, 1952, and a single bird at Tsubota, August, 1953. (CNHM, 1 female, 2 sets of eggs.)

Pandion haliaetus. Osprey. At least four Ospreys were observed between Tsubota Mura and Toga Shrine in April and May, 1953. The first record came from Lake Tairo, April 6, 1953, and many ospreys were later observed there. A pair was observed soaring over the ridge behind the Tsubota High School, April 12, 1953.

On May 25, as McClure and I hunted for murrelet nests along the rocky shore near Toga Shrine, an osprey passed over our heads carrying a large fish in its talons. Later, at Lake Tairo, we watched an osprey dive into the water and come up with a carp.

Three ospreys were seen soaring together over Lake Tairo on June 3, giving their weak, whistling call; and, as I watched, a fourth swept in from over the ridge to the east.

**Falco peregrinus.* Peregrine Falcon. Single Peregrines were observed April 5 and August 27, 1953, at Tsubota Mura, and May 23, 1953, at Ako Mura. The many rocky cliffs along the Miyake coast offer excellent nesting sites for the Peregrine, but there is no evidence of it breeding there. The only previous records from the Izu Islands came from Hachijo Jima.

Bambusicola thoracica thoracica. Bamboo Partridge. Abundant. With the White-eye, Brown-eared Bulbul, and Bush Warbler, this is one of the birds best known to Miyake residents. Several could be heard calling daily, even during August. The call was especially noticeable in April and May. Eighteen individuals were heard calling, May 23, 1953, between Tsubota Mura and Lake Tairo. Five adults were collected in April and May, and a brood of five chicks was taken in May, 1953. (CNHM, 2 adults, 5 downy young.)

**Gallinula chloropus indica.* Moorhen. At least one pair was observed and frequently heard in the rushes along the east shore of Lake Tairo in May, 1953. The splashing sound made as they walked among the rushes first attracted us, but they were shy and difficult to observe. A male was collected, May 30.

**Charadrius mongolus stegmanni.* Mongolian Plover. I collected a male on the rocky coast near Tsubota Mura, April 13, 1953. This was the first Mongolian Plover ever seen by my Miyake friends, but others may have been passed off as "*Umi Shigi*" (Sea Snipe), the local name used for all shore birds. Shirai gives Oshima as the only Izu Island locality for this species, and it appears that it passes through the Izus as a rare migrant.

**Actitis hypoleucos.* Common Sandpiper. The first Miyake Jima record for this species was a pair collected at Lake Tairo, April 6, 1953, by Dr. Robert Smith. The local fishermen say that sandpipers are frequently seen along the beach and seawall at Tsubota Mura during April. I collected three from a flock of six, near Tsubota Mura, on the rocky shore, April 13, 1953. Flocks of more than ten birds each were observed along the Tsubota sea-wall, August 29 and 30, 1953. (CNHM, 3 skins.)

Heteroscelus incanus. Wandering Tattler. Tattlers were observed daily in May, singly or in small flocks, along the coast between Tsubota Mura and Miike Beach. Dr. McClure collected one, May 28, 1953, but the specimen was not saved. Two were seen on the Tsubota shore, August 26, 1953.

Scolopax rusticola rusticola. Eurasian Woodcock. A rather common summer resident. Three were observed April 5, 1953, one each on April 12 and 13, 1953, one on May 26, five on May 30, one May 31, and four June 2, 1953. The bird is

rather difficult to see during the day, but pairs can sometimes be seen at dusk in slow courtship flight over the tree-tops.

A juvenile was caught and given to me by Tsubota schoolboys, May 26, 1953, and I shot an adult female, May 30. Mr. Gonichi Yamada, of Tsubota, showed me a nest in a camelia forest near Lake Tairo, April 12, 1953. As we approached, we flushed the incubating bird from four eggs in a hollow scooped out in the dead leaves and grass. (CNHM, 1 adult, 1 juvenile.)

**Larus crassirostris*. Black-tailed Gull. Dr. McClure saw one at Miike Beach, May 24, 1953.

Synthliboramphus wumisuzume. Japanese Murrelet. The purpose of the first 1953 trip (April 5 and 6) was to study this interesting species. It was difficult to persuade local seamen to make the long journey from Miyake to Sanbondake Reef, partly because of the high seas and partly because *tengusa* fishing was more profitable. Smith, McClure, Morioka, and I made the journey on April 5, but very high seas prevented a landing at the reef. Even so, the trip was most profitable! We followed the Miyake coast from Tsubota Mura to Ma Point and then headed directly toward Sanbondake.

We began to see murrelets about a half mile from Ma Point. The high seas prevented an accurate count, but there were more than fifty near the Miyake Coast, scattered in groups of two and three. We soon left this gathering and only scattered individuals were seen until we got within a mile of Sanbondake Reef, where they again became common. (See Figure 2.) They were quite tame and allowed us

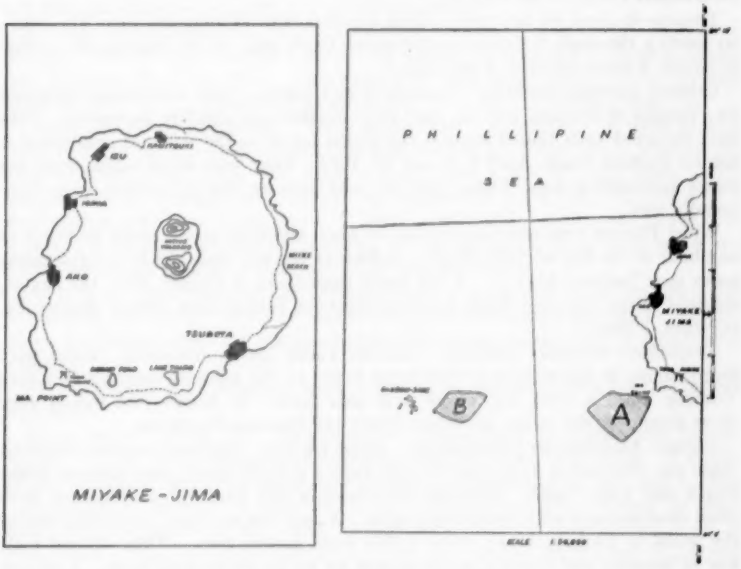

FIGURE 2. (*Left*) Miyake Jima. (*Right*) Sanbondake Reef and adjacent Miyake Jima coast. (A) and (B) indicate concentrations of Japanese Murrelets (*Synthliboramphus wumisuzume*) observed on April 5, 1953.

to approach within fifty feet or less before diving. They seldom took to the air, doing so only when, surfacing from a dive, they found our boat a few feet away. Then they would fly for sixty or seventy yards, hit the water, and immediately dive again.

Because we were unable to land and thus had no way to determine accurately the size and condition of the colony, we collected selectively, taking only twelve specimens. Breeding is said to be at a peak in April and, with this in mind, the sex ratio and gonad condition of our specimens are interesting. Of twelve birds collected, ten were females and two were males. Since plumages are identical, we had no way of distinguishing the sexes before shooting. A completely developed egg was found in one female, eight had medium-sized ovaries, and in one the ovaries were small. The testes were of medium size in one male and small in the other.

Stomachs of the specimens contained small minnows, tiny univalve molluscs, and, in one, a crab larva. The molluscs are evidence of bottom-feeding.

We were unable to reach Sanbondake again until McClure and I went on May 26, 1953. Not a single murrelet was seen. This time we were able to land, and we found the breeding grounds a grim reminder of two years of use as an U. S. Air Force bombing range (1951–1952). Twisted bomb fragments and carcasses of shearwaters and murrelets littered the flat rocky strip of shore where the birds formerly bred. A thorough search yielded no murrelets, but there was limited evidence of breeding. Several grass nests were found tucked far under large boulders, and broken egg-shells were numerous. Under one large boulder I counted seven nests. The evidence seemed to indicate that at least a few birds may have reared young in 1953. I was able to salvage a few skeletons of both murrelets and shearwaters (*Puffinus leucomelas*).

Because in April we had seen a large concentration of murrelets near Ma Point, we made a thorough but unsuccessful search there May 25 for evidence of nesting. (CNHM, 3 skins; UMMZ, 3 skeletons.)

Columba janthina janthina. Japanese Wood Pigeon. Not uncommon, although Dr. Tanaka of Tsubota told me that their numbers are steadily decreasing. Five were observed each time I entered the shrine forest in the volcanic amphitheater behind Tsubota Mura, April 5, 6, and 12, 1953. Four were heard calling from the ridges surrounding Lake Tairo, April 13, and pairs or lone individuals were occasionally seen.

Wood Pigeons were more in evidence in May, and their cooing could be heard at any hour of the day at Lake Tairo. A flock of ten was observed in a cryptomeria grove near Tsubota, May 31. I saw many large flocks in August, 1953; the largest, eighteen birds, was seen flying over the Tsubota Junior High School, August 24. (CNHM, 1 skin.)

Streptopelia orientalis orientalis. Eastern Turtle Dove. Common. Eight were heard calling in the vicinity of the shrine forest in the volcanic amphitheater near Tsubota, April 6, 1953, and many were seen daily. In August, the forests were silent except for the calling of Turtle Doves and Bamboo Partridges.

Cuculus poliocephalus poliocephalus. Little Cuckoo. Common summer resident. None was observed in April, but in May, 1953, I counted seven pairs between Miike Beach and Lake Tairo. Although considered a shy bird, Miyake cuckoos were often observed and were surprisingly tame. A pair was seen and heard daily within the limits of Tsubota Mura, often calling from garden trees. They showed little fear of humans, and it was a simple matter for me to collect both birds. A cuckoo was heard calling near Tsubota at 11 P.M. on a bright moonlit night, May 25, 1953.

I collected four specimens, one of which is in hepatic plumage. The other three are in gray adult plumage, but two of them are reddish around the throat and

shoulders. Mr. Deignan, who examined my red-plumaged specimen, suggests, in a letter to me, as follows: "My material seems to show that all immatures begin as squamated gray birds, but that some go through an hepatic plumage and then into the gray of the adult." My Miyake specimen, he feels, "seems to be in subadult plumage, passing from this second-stage hepatic plumage into that of a full adult." In the other two reddish specimens it appears that the change is nearly complete. Such a plumage change could conceivably take two or three years, although the bird becomes physically adult in one year. (CNHM, 4 skins.)

Ninox scutulata. Brown Hawk Owl. Morioka and I heard the distinctive call of the Hawk Owl at dusk, April 5, 1953, at Lake Tairo. I heard another calling from the slopes of Mount Oyama, late at night, May 25, 1953.

Apus pacificus pacificus. White-rumped Swift. Common summer resident. Large breeding colonies were found at the cormorant cliffs at Miike Beach and at Toga Shrine, May, 1953; on the cliffs north of Ako Mura, July, 1952; at Igaya Mura, July, 1952; and at Sanbondake Reef, May, 1953. Several smaller colonies were also observed. Dr. Van Philpot, who climbed Mount Oyama in May, 1953, reported seeing swifts in abundance at the crater. My earliest record was April 12, 1953, when I saw five at Tsubota Mura. (CNHM, 4 skins.)

**Alcedo atthis*. River Kingfisher. I saw two at Lake Tairo, August 30, 1953.

Dendrocopos kizuki matsudairai. Pigmy Woodpecker. Common. I collected eight specimens. Drumming was often heard in early April. A drumming male was collected from a cryptomeria, April 14, 1953. By late May family groups were seen daily. I collected an adult and two young from such a group, May 31, 1953, and two more immatures, June 3. (CNHM, 5 skins.)

Hirundo rustica gutturalis. Barn Swallow. I recorded this species only three times. A flock of eight was seen perched on electric wires at the veterinary station near Tsubota, April 12, 1953. Two more were seen there the following day and again on April 14. I collected a female, April, 12, 1953. (CNHM, 1 skin.)

Corvus levaillantii japonensis. Thick-billed Crow. Abundant. A flock of over forty was seen frequently in April, May, and August, 1953, and April, 1954, at the Tsubota Mura water front. On April 6, 1953, I saw a pair of Thick-billed Crows carrying nesting material at Tsubota. An apparently active nest was found in a shrine forest near Lake Tairo, April 12, 1953. Both adults circled and cawed continuously at us while we were in the area. We did not climb to the nest, which was 35 feet above the ground in a Black Pine (*Pinus thunbergii*).

On May 27, 1953, McClure and I found a nest in a gigantic Black Pine on a cliff overlooking the ocean. The nest was sixty feet up in the tree and about 200 feet above the rocky coast. It contained three half-grown young, two of which were collected.

All crow flocks were observed with care, and no Carrion Crows (*Corvus corone*) were seen.

Parus major. Great Tit. Very common, particularly in cryptomeria forests. We often heard them singing from trees near the inn in Tsubota Mura. A family group of one adult and five begging juveniles was seen in front of the inn, June 2, 1953.

Parus varius owstoni. Varied Tit. Very common resident. Thirty to forty birds could be seen in a day afield. Many were observed investigating holes in trees, April 13 and 14, 1953. Often I mistook their drumming for that of *Dendrocopos kizuki*. I collected six adults. (CNHM, 6 skins.)

Ixos amaurotis amaurotis. Brown-eared Bulbul. Abundant and conspicuous. More than fifty were observed daily in April, and they were only slightly less in evidence on other trips. They seemed to be more common on the wooded slopes of

Mount Oyama than near the coast or at Lake Tairo. Bulbuls are noisy, having a variety of calls, and they sometimes imitate other species. The bulbul imitation of a Frog Hawk, heard at Lake Tairo, April 13, 1953, was an unusually accurate example.

Troglodytes troglodytes mosukei. Wren. Not uncommon around Lake Tairo and in heavy forests on the slopes of Mount Oyama. In April and May, their song was heard frequently, but they were not often observed. Single adults were collected April 13 and 14, 1953, and I collected a juvenile at Lake Tairo, May 26, 1953.

Mr. Deignan noted that my specimens, which he examined, are very much darker everywhere than specimens of *fumigatus* from Honshu and Shikoku. The Miyake specimens agree perfectly with Austin's and Kuroda's (1953) description of *utanoi* of Kyushu; being, in fact, much darker than specimens of "*utanoi*" in the USNM, which are indistinguishable from *fumigatus*. (CNHM, 2 skins.)

Zoothera dauma aurea. Ground Thrush. A woodcutter gave me a juvenile Ground Thrush, which he had found, nearly dead from starvation, in a forest behind Igaya Mura, July 25, 1952. (CNHM, 1 skin.)

Turdus celaenops celaenops. Seven Islands Thrush. Common resident. Although we saw them in a variety of habitats, we found them particularly abundant in April, 1953, in camelia forests. April 12, a typical day afield, I counted twenty-three. McClure and I found a nest fifteen feet above the ground in the fork of the lowest branch of a gigantic live oak, May 27, 1953. The nest, made of mud, moss, and grass, contained two half-grown nestlings, which were collected.

Three empty nests were found, all in cedar trees, May 31, 1953. All were between six and eight feet above the ground and made of moss, roots, mud, and grass. (CNHM, 8 skins; UMMZ, 7 skins, including 2 immatures and 2 nestlings.)

Monticola solitarius magnus. Blue Rock Thrush. Abundant along the rocky shores. Singing males were particularly conspicuous on April 5 and 6, 1953. The song was most frequently given from the top of a large boulder on the rocky shore, but the fluttering flight song was also common. Occasionally males were seen singing from the top branches of large pines overlooking the shore. I counted four singing, displaying males in 200 yards of coastline near Tsubota Mura, April 6, 1953.

On May 24, 1953, I collected two young birds from a nest in the cinders near the crater of the 1940 volcanic eruption. This nest, nearly half a mile from the ocean, was the only example we found of Rock Thrushes breeding away from the rocky coast.

In the spring, they were observed only in barren, rocky habitats, however, in late May many were seen foraging in the forests, fields, and gardens, sometimes more than half a mile from the shore. (CNHM, 6 skins.)

Erithacus akahige tanensis. Japanese Robin. Abundant in April and May in dark forests. The songs and call notes of robins could be heard almost continuously throughout the day at Lake Tairo. Eighteen were observed there, April 12, 1953, in a rather detailed survey of the forests surrounding the lake.

In the shrine forest behind the Tsubota High School, I counted nine singing males, April 5, 1953. In early April the females remain quite out of sight while males sing from conspicuous branches. Many females were seen carrying food in May, but no nests were found. Courtship displays were observed both in April and May, 1953. The following example is quoted from my field notes of April, 1953. "I first noticed the male hopping from branch to branch, singing continuously. Soon he jumped down to a dead horizontal branch about four feet above the ground. As he sang, the female hopped up next to him. The male immediately bowed forward displaying a widely spread, waving red tail and fluttering his wings. He continued to sing with his bill pointed straight up, giving the female full view of his brilliant throat backed by the waving tail."

Another male was observed displaying similarly from a twenty-foot branch, and a third was seen giving the same display from the ground. (CNHM, 3 skins; USNM, 2 skins.)

Phylloscopus ijimae. Ijima's Willow Warbler. Easily the most abundant summer bird on Miyake Jima. It is found wherever there is dense vegetation, from tangles of small shrubs to dense forests of gigantic live oaks and camphors, where it seems to prefer the lower branches. In many places it is so abundant that accurate counts are extremely difficult. Its weak, thin song was heard constantly in April and May. On April 6, 1953, I stood in a shrine forest near Tsubota Mura and counted ten birds singing within sight.

The differences between this form and *P. occipitalis* in the field are quite striking, and I am in complete agreement with Austin and Kuroda (1953) who write that it "is so vastly different from them (*occipitalis*) in its song and its nesting habits that it seems better to regard it as specifically distinct." (CNHM, 5 skins.)

Horeites diphone ijimae. Bush Warbler. Next to the preceding species this is probably the most abundant bird on the island, but limited only to second-growth areas such as brushy fields, brushy clearings in forests, forest borders, wind-swept crests of cliffs, etc. I collected eight singing males between April 5 and June 2, 1953. All were ragged specimens in various stages of molt around the throat.

A dome-shaped nest, found May 26, 1953, was three and one-half feet from the ground in dense bamboo grass (*Phyllostachys* sp.). It was made of grasses and contained four chocolate-colored eggs. (CNHM, 3 skins.)

Locustella ochotensis pleskei. Island Grasshopper Warbler. Common summer resident, locally abundant. None was observed in April, but in May, 1953, they were met with daily. The wind-swept knoll on Ma Point, behind Toga Shrine, provided a particularly suitable habitat, and grasshopper warblers were abundant there. The vegetation, which consisted mainly of a very thick tangle of bamboo grass and twisted recumbent camelia trees, formed an impenetrable mass, knee-high near the ocean, increasing to heights of fifteen feet farther inland. The bird population diminished as the height of the foliage increased. Such dense foliage made the collecting and recovery of specimens difficult; but the warblers were quite tame and curious, and if forced to take cover they soon reappeared to examine the intruder, and they were easily "squeaked" to within gun range. As I hunted for a freshly-collected specimen in shoulder-high vegetation, I counted eight birds singing within fifty feet of me. They have a typical thin warbler song and a buzzing, grasshopper-like flight song.

Other dense concentrations were found in fields of thick brush, loose pine forests with dense floors of bamboo grass (*Phyllostachys* sp.) where they were supplemented by *Phylloscopus ijimae*, and in brushy borders of cultivated or grassy fields. Miyake Jima residents apparently do not distinguish between this species, *Phylloscopus ijimae*, and *Horeites diphone*, and they call all three species "*Uguisu*," the Japanese name for the Bush Warbler.

**Acrocephalus arundinaceus.* Great Reed Warbler. I heard the unmistakable song of this species coming from a patch of reeds behind Miike Beach, at twilight, May 27, 1953. Another was observed as it sang from the top of a lone bush in a field of wet grass near Tsubota Mura, June 3, 1953.

**Muscicapa latirostris.* Broad-billed Flycatcher. I collected a pair at Tsubota Mura, June 3, 1953. (CNHM, 2 skins.)

**Motacilla cinerea.* Gray Wagtail. A black-throated male was seen hopping along the shore at Lake Tairo, April 12, 1953. White-throated birds were seen there April 13 and 14, 1953. No others were observed.

**Bombycilla japonica*. Japanese Waxwing. In April, 1954, Dr. Tatsuo Tanaka, of Tsubota, showed me three specimens of this interesting species, which he said had been collected in March, 1954, by a resident of Kamitsuki Mura. The only previous Izu Island records come from Hachijo Jima.

Zosterops japonica stejnegeri. Japanese White-eye. Abundant. I counted fifty in two hours of collecting, April 5, a typical day. They were particularly abundant in the cryptomeria forests and camelia orchards. Birds collected in April had mouths stained yellow with camelia pollen. A nest with four young was found in late May, 1953, nine feet above the ground in a small maple in the garden of the Tsubota Mura Primary School.

Flocks of white-eyes came daily in August, 1953, to pick at the ripe fruit of a peach tree near the inn at Tsubota. Another interesting feeding habit observed in August is quoted from my notes: "Directly opposite my window there was a row of small camelia trees. Periodically during the day, flocks of white-eyes moved into the trees and began poking through the leaves. Several small white moths were flushed from the leaves, chased, seized, and immediately swallowed. There seemed to be no end to the number of moths and this method of feeding was observed daily." (Tsubota Mura, August, 1953.) (CNHM, 4 skins.)

Passer montanus. Tree Sparrow. Abundant in the vicinity of houses and in stands of large pine. Nests are commonly placed under the tiles and thatch of roofs. Several nested, in April and May, in crevices in the pines overlooking the shore at Tsubota Mura.

Chloris sinica. Oriental Greenfinch. Common and well known. Islanders call it "Daikon Dori" (Daikon Bird), because it is often seen in the fields of giant white radishes called "daikon." Green-finches were particularly common on the southwest side of the island near Ako Mura, where the slopes of Mount Oyama are more gradual and cultivated fields are more common. A nest with four young was found on May 31, 1953, in a cedar tree at the edge of a cultivated field.

Emberiza spodocephala personata. Black-faced Bunting. On April 6, 1953, Dr. Smith observed a small flock at Lake Tairo. I collected a female from a flock of six individuals on April 13, 1953, at Lake Tairo. Another small flock was seen there, April 14.

Emberiza cioides ciopsis. Meadow Bunting. Common and conspicuous. I observed twenty-seven in two hours of collecting near Tsubota Mura, April 14, 1953. Like *Chloris sinica*, Meadow Buntings were more common on the gradual slopes of Mount Oyama near Ako Mura, where cultivated fields are more numerous. Two nests were found, both completely concealed in thick bamboo grass, less than three feet from the ground. Three adults and two broods of nestlings were collected. (CNHM, 1 skin.)

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Department of Zoology, Colgate University, Hamilton, New York, January 30, 1956.

VARIATION IN *SEIURUS NOVEBORACENSIS*

BY STEPHEN W. EATON

THE NORTHERN WATERTHRUSH is one of the New World's most widely ranging warblers. It is a characteristic breeding bird by waters associated with our boreal forests, may be seen on migration in every state of the Union, and winters as far south as Venezuela (Wetmore, 1939).

Three subspecies have been recognized by the A.O.U. Committee on Nomenclature: the nominate race, *notabilis* Ridgway (1880), and *limnaeus* McCabe and Miller (1933). Burleigh and Peters (1948) have recently described a fourth race, *uliginosus*, from Newfoundland.

This paper attempts to analyze critically the variation indicated by these trinomials and to point out severe weaknesses and misconceptions regarding them. Variation in birds may be of several types such as individual, sexual, age, and geographic. Only after a study of the first three can the fourth adequately be determined. The approach here follows that order.

ACKNOWLEDGEMENTS

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For patient guidance and advice I wish to thank Professors Arthur A. Allen, William J. Hamilton, Jr., and Robert T. Clausen.

Dean Amadon, Ernest P. Edwards, Abelardo Moreno, Kenneth C. Parkes, and Ellen E. Eaton have aided in many aspects of the study. This is a portion of a thesis presented to the faculty of Cornell University in partial fulfillment of the requirements for the Ph.D. degree.

INDIVIDUAL VARIATION

Color of Venter.—On the basis of the coloration of the venter, I divided the specimens into five groups—*white, white to medium, medium, medium to yellow, yellow.* For color standards, three specimens were used as comparative material—*white* by Carnegie Mus.

No. 91778, *medium* by Carnegie Mus. No. 8327, *yellow* by Mus. Comp. Zool. No. 204552. Intermediates (W-M, M-Y) were estimated, that is, no individual skin was used as a color type for these two additional color categories.

It will be seen by referring to Figure 1 that there is a great deal of individual variation in the five categories mentioned above over a very broad area from Alaska to Newfoundland.

Another variation in color of the venter is shown by twelve individuals. These specimens have a distinctly W-M or M belly with a distinctly white throat. The line of demarcation in color is abrupt.

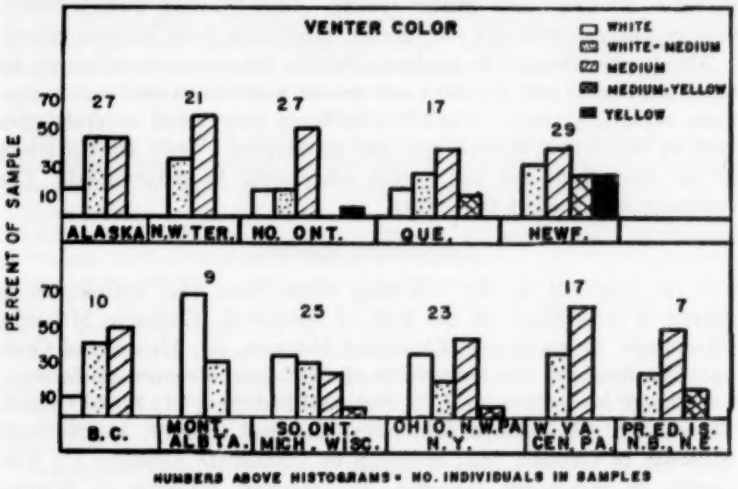

FIGURE 1. Histograms showing percentages of five categories of ventral coloration in the Northern Waterthrush. The data for males and females are combined.

The antithesis of this color pattern was found in one skin from Cockran District, Ontario; the throat of this bird was distinctly yellow and the breast white.

Nine of twelve individuals from British Columbia were heavily streaked on the venter. The same degree of heavy streaking also occurred in individuals distributed as shown below (for distribution of samples see Figure 2).

Sample Number	1	2	3	4	5	6	7	8	9	10	11
Number of heavily streaked individuals	3	1	2	0	0	9	3	3	1	0	5

Color of dorsum.—To study variation in dorsal color, three study skins were selected as types. One called *brownish wash* was repre-

FIGURE 2. Map showing localities from which June- and July-taken specimens were examined and the grouping of these localities into eleven samples: 1, Alaska; 2, Northwest Territories, Saskatchewan, and Manitoba; 3, northern Ontario; 4, Quebec; 5, Newfoundland; 6, British Columbia; 7, Montana and Alberta; 8, southern Ontario; 9, Ohio, New York, and northwestern Pennsylvania; 10, central Pennsylvania and West Virginia; 11, Nova Scotia, New Brunswick, and New England.

sented by Nat. Mus. Canada No. 30325, collected August 31, 1944, on the Canol Road of Yukon Territory. The second called *black wash* was represented by Cleveland Nat. Hist. Mus. No. 41315, collected in Tifton County, Georgia, September 15, 1941. The third called *greenish wash* was represented by S. W. Eaton No. 285, collected September 19, 1948, near Ithaca, N. Y. The criteria used in selecting these skins were that they should be less than 10 years old and birds in fresh fall plumage. No sexual differences in color were noted, so members of both sexes were used.

Birds from Alaska, Yukon Territory, Northwest Territories, Manitoba, northern Ontario, and Quebec were mostly of a brownish wash. Birds from Ithaca, New York, one from the St. John's Lake region of Quebec, and three from central Manitoba and Saskatchewan were classified as greenish or between brown and greenish. Birds from the

southern part of the breeding range in Michigan, Minnesota, Ohio, and New England were not considered because all the specimens examined from these areas were probably not very close to their breeding grounds.

Only four specimens with a black dorsum were present in the birds in fall plumage, and these were from widely scattered parts—Northwest Territories, British Columbia, northern Saskatchewan, and southern Ontario.

Median Crown Stripe.—This segment of the color pattern is a highly variable character. The stripe was absent in some individuals, was a short, well-defined line in others and in a few was almost in the form of a crown patch, as in the Ovenbird (*Seiurus aurocapillus*). The frequency of four classifications is shown below. (Most individuals below were collected in May, June, and July, but a few fall-taken males, females and immatures were used here.)

	Absent	*Linear*		*Patch-like*
		1 to 5 mm.	6 to 14 mm.	
Number of individuals	10	75	158	9

The color of the stripe varied from white (in white-ventered birds) to a buff color (usually in medium- or yellow-bellied individuals). It is more discernible in slightly worn spring and early summer birds. In fresh fall plumage, it is almost always concealed by the distal coloration of the feathers, which is similar to the general crown and dorsal coloration. This variation showed no geographic correlation.

Color of Superciliary.—In general, those individuals with a white venter also had a white superciliary stripe, and conversely, those with a medium to yellow venter, a buffy one. Individuals with a white throat and medium to white belly had a white superciliary. The one individual with a medium throat and white belly had a buffy superciliary.

Variation in Size.—Figures 3 and 4 show individual variation of breeding birds in two measurements—wing (cord) and bill (from anterior edge of nostril to tip). Individual wing measurements varied from a low of 70.0 to a high of 82.0 mm. Bill measurements varied from 8.9 to 13.1 mm., the last measurement is that of the type of *notabilis*. Aside from this specimen, the longest bill measured 11.1 mm.

Variation in Wear.—Females on the breeding grounds take a greater share in raising the young and hence become more worn than males. Some extremely worn individuals show a fairly distinct collar

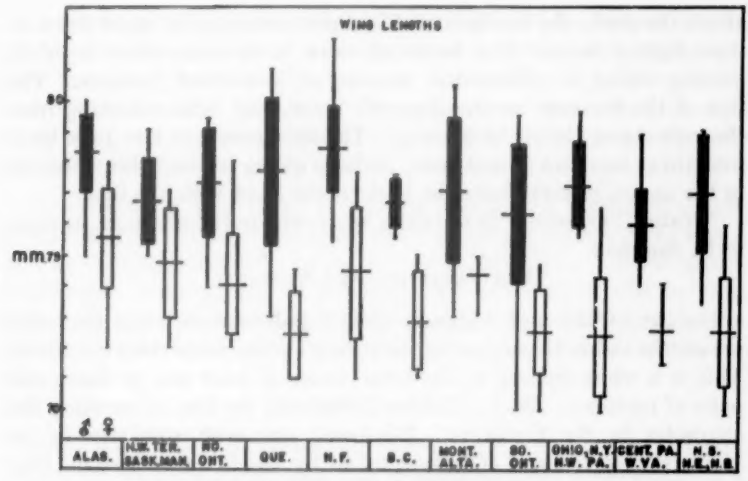

FIGURE 3. Variation in the length of the wing (chord) in the Northern Waterthrush. Sample 1 (Alas.), 15♂♂, 10♀♀; Sample 2 (N. W. Ter., etc.), 13♂♂, 10♀♀; Sample 3 (no. Ont.), 15♂♂, 11♀♀; Sample 4 (Que.), 11♂♂, 5♀♀; Sample 5 (N. F.), 19♂♂, 8♀♀; Sample 6 (B. C.), 5♂♂, 5♀♀; Sample 7 (Mont., Alta.), 6♂♂, 3♀♀; Sample 8 (so. Ont.), 20♂♂, 7♀♀; Sample 9 (Ohio, etc.), 16♂♂, 7♀♀; Sample 10 (cent. Pa., W. Va.), 13♂♂, 3♀♀; Sample 11 (N. S., etc.), 5♂♂, 6♀♀.

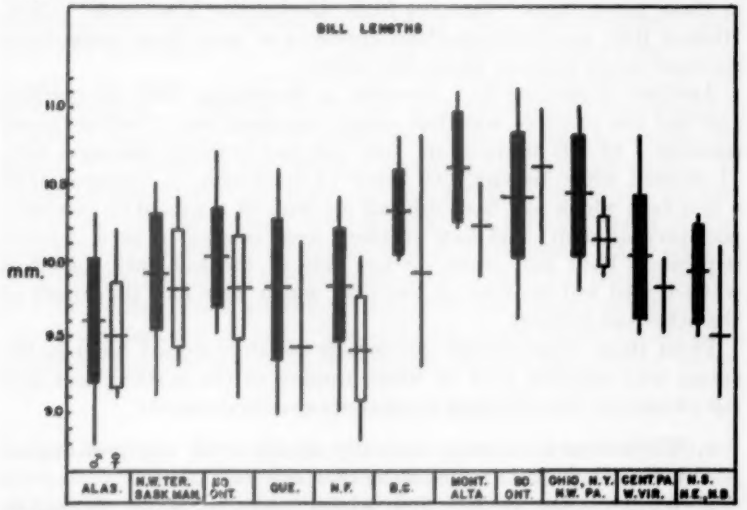

FIGURE 4. Variation in the length of the bill (nostril to tip) in the Northern Waterthrush. Number of individuals in samples same as in Figure 3.

about the neck; the feathers of this region are actually worn down to their lighter bases. The backs of worn birds often show a subtle barring owing to differential wearing of individual feathers. The tips of the feathers become jaggedly worn, and light reflecting from these produces the slight barring. The hind crown in late June birds sometimes becomes almost bare, perhaps owing to the habit, common in the genus, of scratching the back of the head with the foot.

"Foxing," especially in the older specimens in fall plumage, appears to be common.

AGE VARIATION AND SURVIVAL

Dwight (1900) and Ridgway (1902) fail to mention a character present in about 57 per cent of the spring and summer skins examined. This is a white-tipping of the inner vanes of from one to four outer pairs of rectrices. W. L. McAtee (1904) was the first to mention this character in the literature. He found one such specimen in the University of Indiana collection taken by David Starr Jordan, May 14, 1875. This specimen was believed to be an abnormality, but after carefully checking this character I believe it to be the normal condition of the plumage following the first post-nuptial molt.

Of 272 specimens taken in May, June, and July, 154 (56.6 per cent) had from a trace to very distinct white spots on the inner vane of the outer rectrices; in 118 (43.4 per cent) specimens no white was apparent even as a trace. There seemed to be a slight geographic variation in these percentages. Samples from Alaska, the Mackenzie Valley, Hudson Bay, and Newfoundland appeared to have these percentages reversed (more without white than with).

Another interesting fact observed in examining birds in nestling and first fall plumage was their almost complete lack of white-tipped rectrices. Of 107 birds in the first fall and nestling plumages only 11 showed white tipping. Of these 11 specimens, it appeared that 6 had tails which had been injured (or were in a partial or complete post-juvenal molt) and new feathers were coming in in a delayed sequence. Four had white on one side of the tail only; two had white-tipped tail feathers on one side, which were half the length of the other tail feathers.

From these observations (percentage of white-tipped birds in the spring and summer, lack of white tipping in the nestling and first fall plumages) the following conclusions can be deduced:

1. White-tipped rectrices normally appear with the post-nuptial molt and indicate a bird more than one year of age.
2. White-tipping in the first winter plumage is an anomalous

condition probably brought about by premature loss of the juvenal rectrices or it is the phylogenetic remnant of a previous, complete post-juvenal molt.

3. More birds in first winter plumage (less than one year old) reach the northern areas of distribution in the spring than do older birds.

In support of this Hann (1948), in a study of longevity of the Ovenbird, found that considering birds in all age classes there was a 55 per cent survival from year to year in Michigan. If the above conclusions with regard to white-tipping are correct and in field collecting random sampling of old and young birds occurs, then survival from year to year in waterthrushes is similar to that in the Ovenbird.

SEXUAL VARIATION

Color.—No sexual dichromatism was noted. This makes the study of life histories a difficult task. It might seem that song would be a good way of spotting the male in the nesting season, but caution must be used here because Hiatt (1943) collected a female Ovenbird which was singing and Todd (1940) mentioned a similar case with *Seiurus motacilla.*

Size.—Females average smaller in wing, tail, bill, and tarsus. In a given population the mean wing length of females usually fell below the smallest wing length of males. However, there was always considerable overlap between the sexes. Tail measurements were similarly distributed but there was less difference between the means for the two sexes. There was much less sexual variation in bill and tarsal lengths. However, in ten out of eleven samples the mean bill length of females fell slightly below the mean for males. In the one sample the mean of the females exceeded that of the males. In tarsal measurements the mean for the females always fell slightly below that for the males. During May and June Northern Waterthrushes can be readily identified to sex in the hand. The females have a brood patch and the males do not. During the nesting season and for a short period afterwards the males are greatly swollen about the cloaca; females are not. This swelling is due to the enlargement of the vas deferens just above its entrance into the cloaca (Salt, 1954).

GEOGRAPHIC VARIATION

The Northern Waterthrush is single brooded, is an early fall migrant, and has no prenuptial molt. Few have been collected during the breeding season in the southern and eastern parts of the breeding

range. In western New York locally breeding birds arrive from the south the last week in April, and by June 9 these birds have started their post-nuptial molt. Migrants may pass through Ithaca until the middle or end of May when some local young are hatching. Stone (1937) said, ". . . The Waterthrush is the first transient land bird to be seen in the Cape May district on southward migration." Color variation is difficult to assess in this species because of the subtle browns and yellows in suffused patterns over wide areas of the body. They may be likened in this regard to our hylocichlas and empidonaces. All of these facts account for our poor understanding of geographic variation in this species.

In studying geographic variation of size characters only June and early July birds were measured because May or late July birds might be migrants. In the analysis of dorsal coloration, birds in fresh fall plumage (July and August skins) were compared because of the lack of the prenuptial molt. Birds collected in the northern United States were not used in this color analysis unless collections were in areas where the birds were known to nest and circumstances suggested they were breeding birds.

Ventral coloration seemed to vary equally in the sexes, but the fall birds were usually yellower than the spring birds so it was decided to use only June and July skins in the analysis of this color variation.

Wing.—This character, if an indicator of general body size, varies in accordance with Bergmann's Rule. Birds from the northern areas of distribution had longer wings. But a look at Figure 3 will reveal that this does not become apparent until we get to Alaska in the west and Newfoundland in the east. The means of samples from New York to Montana north to Great Slave Lake vary little more than a millimeter. There was no distinct break in any region, but a gradual cline occurred from south to north. The mean of the sample from West Virginia and central Pennsylvania was only 2.3 mm. less than that of the sample from Alaska.

Tail.—Although more variable than the wing, probably owing to differential wear, this character showed a similar trend—increase in length from south to north.

Bill.—Of six characters analyzed, bill length (from nostril to tip) seemed the best correlated with geography, but individual overlap occurred in samples from all parts of the breeding range. Birds from northwestern Montana and southwestern Alberta had the longest bills and from there east to New York only a 0.3 mm. decrease in mean length occurred. From Montana north to Alaska a decrease of 1.0 mm. was found. In the east a similar trend occurred from New

York to Newfoundland. If Allen's Rule may be correctly applied to the avian bill, this variation agrees.

Tarsus.—From measurements obtained, though not included here, no geographic variation was noted.

Color of Venter.—The percentage of white-ventered birds in the samples decreased from about 70 to 30 per cent from Montana to New York (Figure 1). From New York northeastward the trend is toward a yellow venter. In the northern parts of the range the percentage of white-ventered birds is about 20 per cent, exclusive of the Northwest Territories and Newfoundland, where none occurred in the samples.

Color of Dorsum.—The sample of birds for analyzing this character was meager because only fall-plumaged (July-Aug.) birds, thought to be close to their breeding areas, were used. From the birds examined it appeared that birds from Alaska to central Quebec were similar in color—what I termed a *brownish wash*. Birds collected in the Ithaca area in July and August had a *greenish wash*. These colors, for the most part, are lost before the birds return to their breeding areas the next spring. It will be a long time before enough fresh fall specimens collected on the breeding grounds are available for study. Thus, this character, though figuring prominently in the descriptions of the past, seems least helpful in a critical examination.

COMMENTS ON SUBSPECIES

Seiurus noveboracensis notabilis.—Ridgway's type was collected on May 10, 1878, at Como, Wyoming Terr., by G. B. Grinnell. Herbert Friedmann was kind enough to send this specimen and the following measurements were obtained—bill (nostril to tip), 13.1; wing, 82.0; tail, 59.0; tarsus, 20.8 mm.; venter M-W; trace of white in tail. The bill exceeded all other specimens examined by more than 2 mm. and the wing by almost 1 mm. Here is Ridgway's description. "Similar to *S. n. noveboracensis* but larger, especially the bill; coloration of upperparts less olive (more greyish sooty), that of the underparts less yellowish, usually white, with little if any yellow tinge."

This long accepted subspecies typified by an aberrant specimen which was probably a migrant, seems unjustified. Nomenclaturally *notabilis* applies to birds from Montana to Alaska yet these two populations are at opposite ends of clines in bill and wing lengths.

Seiurus noveboracensis limnaeus.—McCabe and Miller (1933) selected as type a male, collected on June 8, 1930, in the Caribou district of central British Columbia. Their diagnosis is as follows; "dorsum between olivaceus black and dark grayish olive; underparts

with yellowish averaging less than in *S. n. noveboracensis* but more than in *S. n. notabilis;* wing and tail averaging small; tarsus as in *notabilis*." . . . Distribution: . . . "central interior British Columbia extending with some diminution of characters through northern British Columbia."

I examined 5 topotypes and 6 other skins from central interior British Columbia and all but three skins agreed well with this description. However, 18 specimens from widely scattered points in the breeding range of northern and eastern populations could not definitely be segregated from this group.

Seiurus noveboracensis uliginosus.—Burleigh and Peters (1948) have recently described this bird as the breeding bird of Newfoundland. The type, a male, was taken at Topsail, Avalon Peninsula, on June 22, 1945. This subspecies they described as the most olivaceous above and yellowest beneath of the four races; bill averaging smaller and wing longer than neighboring populations.

I have included much of their material in my analysis, and variation in size and color is summarized in Figures 1, 3, and 4. This indicates that the Newfoundland birds are the northeastern clinal extreme in bill length, wing length, and degree of yellow in the venter.

CONCLUSIONS

In the light of these data, which show an unusual amount of individual variation and slight trends toward geographic variation, it would seem best to treat the species as monotypic. The identification of migrants and wintering birds, unless "ultratypical," would be highly subjective.

Amadon (1949) in a discussion of the 75 per cent rule for subspecies concludes that 75 per cent of the individuals of one race must be clearly separable from all the other individuals of the other race; or 96 per cent of one population separable from 96 per cent of the other. This can not truthfully be done with this species. Here, it seems to me, is a case like that of *Erithacus rubecula.* Lack (1946) in his taxonomy of the European Robin says, "it is both simpler and more accurate to describe subspecific variations in terms of geographic trends, and to omit altogether the tyranny of subspecific names."

The temptation to describe the Alaskan population, the Montana-Alberta population and the West Virginia-Central Pennsylvania populations has presented itself, but this would lead to greater confusion and misunderstanding. The best solution I think is to treat the species as monotypic and to indicate geographic trends as shown here.

SUMMARY

Six individually varying characters are described in the Northern Waterthrush (*Seiurus noveboracensis*).

White tipping of the inner vanes of the outer two to four rectrices appears to be typical of the postnuptial plumage. Lack of this white tipping is characteristic of the postjuvenal plumage.

Sexual variation is described.

Geographic variation is described, and in view of the clinal and rather slight nature of the variation it is suggested that the species be regarded as monotypic.

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THE NESTS OF *PITANGUS LICTOR* AND *CORYPHOTRICCUS PARVUS*

BY F. HAVERSCHMIDT

AMONG the numerous Tyrannidae occurring in Surinam, several are confusingly similar in coloration, but five species are particularly interesting as they differ mainly in the shape of their bills and in size. The almost identical head markings of these birds, which are considered to belong to four different genera, give the evolutionist something to ponder (Skutch, Auk, 68: 30, 1951). These five species are *Pitangus sulphuratus*, *Pitangus lictor*, *Myiozetetes cayanensis*, *Megarhynchus pitangua*, and *Coryphotriccus parvus*.

As regards their nesting, these five species can be divided in three groups, those which make a domed structure with a side entrance, those which build an open cup nest, and one which nests in holes. *Pitangus sulphuratus* builds a domed structure with a side entrance (Plate 12) as does *Myiozetetes cayanensis*, although the latter's nest is smaller and rounder. *Megarhynchus pitangua*, on the other hand, makes a rather frail open cup nest (Skutch, *op. cit.*). As early as 1910, the nest of *Pitangus lictor* was correctly described by the Penard brothers (De Vogels van Guyana, Vol. 2: 246, 1910) as "a rather flat open nest of grasses and leaves" but a number of subsequent writers apparently have confused it with the bulky domed nests of *P. sulphuratus* or *M. cayanensis*, e.g. Young (Ibis, 1929: 228), and even the much experienced Miss E. Snethlage (Journ. für Ornith., 83: 535, 1935) while H. Snethlage (Journ. für Ornith., 76: 717, 1928) apparently had never seen a nest himself as his description appears to be a literal translation of the Penards' remarks. I can corroborate the Penards' statement that *Pitangus lictor* differs wholly from *P. sulphuratus* in making an open cup nest.

On February 12, 1956, I flushed an incubating *P. lictor* from its nest in a young shade tree (*Erythrina glauca*) in the coffee plantation behind my garden near Paramaribo. The nest was made at a height of about 4 meters on a side branch of the main stem which had a diameter of about 20 cm. The tree stood at a distance of about 30 meters from one of the main trenches in the plantation where *P. lictor* as a water loving bird is ever present. I collected the sitting bird which proved to be the female (Leyden Museum No. 2417). The nest (Plate 12) was neatly built of small and dry roots and branches and the nest cup was lined with very fine dry roots. In this way it differed from the description by the Penards' as it contained no grasses or leaves whatever. The outer diameter of the nest cup was about 7

NESTS OF THE DERBY AND LICTOR FLYCATCHERS IN SURINAM. (*Above*) Nest of *Pitangus sulphuratus* at Zanderij, February 26, 1950. (*Below*) Nest of *P. lictor* at Paramaribo, February 12, 1956. Photographs by F. Haverschmidt.

NESTING OF THE WHITE-RINGED FLYCATCHER (*Coryphotriccus parvus*) AT ZANDERIJ, SURINAM, SEPTEMBER 2, 1956. (*Above*) Nest tree (arrow indicates nest hole). (*Below*) Nest and egg in opened hole. Photographs by F. Haverschmidt.

cm., its depth 3 cm. The clutch consisted of three incubated eggs, which on a creamy white ground color had a great many violet spots and blotches forming a broad ring around the large end. Their measurements were: 19 × 15.1; 19.5 × 15.1; and 18.9 × 15 mm.

Pitangus lictor is a common bird in the coastal area of Surinam, but it has a definitely more restricted habitat than *P. sulphuratus*, *M. cayanensis*, or *M. pitangua*, being almost wholly confined to the neighborhood of water (the edge of the mangroves; along creeks and trenches, provided these are lined, or even better, overgrown with shrubbery, bushes, and trees). Here it likes to sit on branches overhanging the water or on stakes and roots in the water, indeed very much like a kingfisher.

Now that it is shown that *P. sulphuratus* and *P. lictor* are so utterly different in their nesting one wonders whether these two species—in fact the only two of the genus *Pitangus*—are really so closely related as to warrant their inclusion in the same genus.

Coryphotriccus parvus is the rarest of the five species mentioned, Hellmayr (Field Mus. Nat. Hist. Publ. 242. Zool. Ser. 13, Part V. 1927. *Tyrannidae:* 136) did not even list it for Surinam. I collected my first specimen near Albina (Marowijne District on September 5, 1954. Now that I know its call note I am convinced that it is not rare but hitherto overlooked because of its strong resemblance to *M. cayanensis* from which it differs by a much stronger bill and a yellow instead of a white throat. Furthermore, it has apparently a restricted habitat for I only found it on sandy soil in second growth provided with some tall, dead trees, which it uses as singing posts and where it nests in holes.

I could find nothing about its nest and eggs in the literature available to me. On July 22, 1956, I observed one of these flycatchers uttering its call note from the top of a dead tree standing among second growth at Negerkreek (Marowijne District). After a short while it clung woodpecker-fashion to the stem of the tree as though inspecting a hole, but I did not see a hole in the tree. I collected the bird, which proved to be a male with greatly enlarged testes (No. 2624, Leyden Museum).

On September 2, 1956, I heard the unmistakable notes of *Coryphotriccus parvus* among second growth on sandy soil near Zanderij (about 50 km. due south of Paramaribo) in a habitat strikingly similar to that at Negerkreek. Suddenly I saw a bird disappear into an old woodpecker hole near the top in a tall dead tree (Plate 13) while a second bird alighted on the top of a tree near by. I tapped against the tree, and the bird left the hole to return after a short time. In

order to examine the contents of the hole, I had to fell the tree, and its fall was broken by the undergrowth so that the part containing the hole remained intact. On opening the hole, I found a neatly built nest made of dry grasses, which filled the bottom of the hole (Plate 13). It contained two eggs, one broken but the other one intact. The shell was rather glossy, of a cream color, and covered all over with streaks and blotches of chocolate brown, which formed an unbroken, solid, broad ring around the large end. The weight of the unblown (fresh) egg was 2.82 grams and its measurements were 20.8 × 16 mm. I collected both birds (Nos. 2682 and 2683, Leyden Museum). It was the female which had spent some time in the hole.

SUMMARY

Five species of Tyrannidae occurring in Surinam, *Pitangus sulphuratus*, *P. lictor*, *Myiozetetes cayanensis*, *Megarhynchus pitangua*, and *Coryphotriccus parvus*, are confusingly similar in coloration and have almost identical head markings but differ mainly in size and in the shape of their bills. *P. sulphuratus* and *M. cayanensis* make bulky, domed nests with a side entrance, *Megarhynchus pitangua* builds an open cup nest. There is confusion in the literature about the nesting of *P. lictor*. This species makes an open cup nest, and a nest with eggs is described. The nest and eggs of *Coryphotriccus parvus* were apparently unknown up till now. It is a hole breeder, and a nest containing two eggs in an old woodpecker hole is described.

P. O. Box 644, Paramaribo, Surinam, September 27, 1956.

VARIATION IN CLUTCH SIZE AT DIFFERENT LATITUDES

BY H. O. WAGNER

More than 100 years ago the South American explorers Prince Wied (1830) and Schomburgk (1848) pointed out that the clutch size of tropical song birds was smaller than that of European song birds. The fact that the number of eggs per clutch generally increases with the latitude has been confirmed repeatedly. This applies to species which originated in the tropics and have extended their range to the temperate zones, as well as to those which, on the contrary, have extended their breeding grounds across the tropics to the equator. It also applies in regions of hot climates and in high mountains.

Hesse (1922) was the first to attempt to interpret this phenomenon. He assumed that the length of the day-light period, and hence the time available for seeking food for the nestlings, determines the clutch size. Starting with this hypothesis Lack (1947a, 1947b, 1948a, 1950) developed a whole complex of questions by means of careful and extensive investigations. He was of the opinion that clutch size at any time is determined by heredity, and that environmental influences are of only subordinate significance. In my opinion, Lack has not given due attention to one important factor, namely living conditions at the time the eggs are laid. Genetically, there is a fixed upper limit for each species; however, it is reached only in optimum living conditions, particularly when the clutch size in itself is fairly large.

During my many years' residence in Mexico, I was continually concerned with the questions of the causes of the smaller clutch size and why smaller clutches are compensated for by increased numbers of broods. The experiments I began were interrupted by my return to Germany. These were intended to determine, by combining two broods, whether Lack's assumption—which runs like a red thread through his writings—that no more nestlings can be reared between the tropics, could be maintained. House Finches (*Carpodacus mexicanus*), which breed prolifically in the neighborhood of the Mexican capital and have a usual clutch size of two eggs (17 clutches had two eggs; three clutches had three eggs), and the Yellow-eyed Junco (*Junco phaeonotus*) with clutches of two or three eggs, were chosen as the test material. Their geographical representatives have larger clutches further north (House Finch up to 7, Yellow-eyed Junco up to 5 eggs). Of eight combined nests two were prematurely

destroyed, and one youngster disappeared from one. Of the remaining five (three of House Finches, two with four eggs and one with five) and (two of Yellow-eyed Juncos, both with four eggs), no influence attributable to the duplication could be detected on the duration of development or the condition of the nestlings. If the number of tests is too small to produce anything conclusive, at least they show that the hypothesis of Hesse and Lack is probably incorrect. It is to be hoped that such experiments, which can be carried out without great difficulty, will be repeated. A few research workers who have lived in the tropics for many years cannot support the theory that the feeding time for the nestlings is of decisive significance. Moreau (1950) after many years of experience in Africa, became convinced that food supply was the critical factor, as it is so seldom fully exploited. The biologist Alexander Skutch, who has been active in Costa Rica for 25 years, also doesn't follow Lack's attempted interpretation (1949 and 1950). Particularly telling among his arguments is the fact that there is no difference in the number of nestlings in species where the female alone, or the parents jointly, feed the progeny. His statement (1950) on the clutch size of the Tyrannidae shows that the females of *Pipromorpha oleaginea*, who look after their nestlings alone, usually feed three young instead of two like the other species mentioned, in which the males share in the care of the brood. Skutch attempts to explain the advantage of small clutches by referring to the danger which snakes represent to broods in the tropics. He assumes that the danger is reduced where the number of young is less, as the frequency of approach of the parents bringing food and the number of young are in a fixed ratio, and so their position is more or less easily betrayed. This attempted explanation is not very convincing, as in seeking for their prey (according to a statement by Prof. H. Kahmann, Munchen) snakes are guided mainly by their sense of smell. As far as we know today, their power of sight is too weak to recognize a bird flying to its nest as such. The other argument with the same drift, that the general danger of discovery increases with the number of nestlings owing to the increase in the noise of begging for food, has yet to be proved. In such cases selection, which originates with the nestlings, would have to reduce the preceding number of eggs, a conception which can hardly be reconciled with our present knowledge. Paynter (1951), and Lack (1948 a and b) attempt to prove this hypothesis in the case of Starlings by showing statistically that the young of small clutches have improved life expectancies. This selective advantage, however, is not so great as to produce by selection a reduction of, for example, from 5 to 4 eggs, i.e. 20 per cent. Since the interpretations of Lack and Skutch

do not appear satisfactory, there is given an added general interest to the question. It is probable that the cause must be looked for in a completely different direction, namely in the physical constitution of the individual at the time of laying.

The production of a clutch entails a considerable physical effort for the bird. The structural materials required are derived from the daily consumption of food, possibly supplemented by the reserve materials stored in the animal. The proportions of the two components at any time can differ considerably. Whenever stored reserves are utilized, the percentage of the total reserve going into the production of each egg can determine the total number of eggs, because when the reserve materials are used up the bird is compelled to cease laying. If, for example, each egg requires 25 per cent of the female's reserve material, the clutch size cannot exceed four eggs. However, the proportion of the reserves can be much greater, and if these are not available or are present only in inadequate quantities owing to unfavorable feeding conditions, they can lead to the complete cessation of reproduction, as is known in the Arctic and in arid and semi-arid regions of the tropics (Hoesch, 1936; Leopold, 1933; Serventy and Whittell, 1948; and Sumner, 1935). The opposite situation, a heavy increase in egg production under exceptionally favorable feeding conditions, also occurs. In years having a plethora of mice and lemmings, owls and birds of prey double the number of their eggs, as the required supply of material for egg production is more than compensated for by the ample supply of prey. Finches from tropical regions are frequently bred in Europe, and when kept under optimum conditions in a cage, the clutch size and number of eggs per year can be considerably higher than in natural conditions.

For species, the production of whose eggs utilizes just or considerably more than the daily consumption of food, there is a danger that the bird will lay more than it can hatch. This is prevented by the cessation of laying as soon as all the brood spots comes in contact with the eggs. Paludan (1951) has investigated experimentally the relationships between brood spot and number of eggs. According to Witschi (1950) the clutch size is probably regulated by the female evidently sensing the extent to which the nest is filled by means of the tactile papillae in the skin of the breast. This sensory perception probably passes via the spinal cord and the cerebral stem to the posterior lobe of the hypophysis, from where the impulse is transmitted on to the secretory anterior lobe to modify the hormone production so as to inhibit the development of the egg and ovulation and to cause the already grown oocytes to degenerate.

Birds which do not use their reserve materials or use them only in

part continue laying after the eggs have been removed from the nest until these materials are exhausted, or become permanent layers (Stresemann, 1934) like domestic poultry. In view of the generally small number of eggs laid, it is not possible to carry out satisfactory investigations in the tropics on the ability to continue laying. In the environs of Mexico City, Brown Towhees (*Pipilo fuscus*) and American Robins (*Turdus migratorius*), whose northern races hatch 4 to 5 eggs as against 2 to 3 in the region investigated, did not make up their clutch after one egg had been removed. Accordingly, the clutch size at any time is probably determined by the food potentialities existing at the time of reproduction in conjunction with the degree of ability to store reserve material, independently of any hereditarily fixed factor. It is possible that the usually smaller number of eggs in warm countries is related to more unfavorable ecological conditions and lessened tendency to store fat as compared with the inhabitants of temperate latitudes. Both are confirmed by my investigations. The ability to form generous reserves of fat seems to be limited to the residents of higher latitudes. This is understandable, as reserves are a prerequisite to the survival of long winter nights and the exertions of spring and autumn migrations.

The reserves for the eggs need not be available in the form of fat. At the time of breeding, female hummingbirds store material for the second egg in the form of supernumerary egg follicles. About six grow to a certain size, one of which developes in a few days into an egg ready for laying. Within 48 hours after it has been laid, a second is formed from the remaining follicles. In a Black-billed Azure-crown (*Amazilia verticalis*) killed immediately before the laying of the second egg, the remaining oocytes were not only completely utilized, but the ovary was so much worn that no one could have guessed its activity of a few hours previously. As I have shown elsewhere (Wagner, 1952), in the case of hummingbirds, clutches of three belong to two birds, where a female whose own nest has been destroyed has laid its developed egg in a strange one.

The relatively poor feeding conditions at breeding time in the tropics are not merely a consequence of the short days, but also of a limited exploitation of them. As soon as a certain degree of heat is exceeded, the instinct to look for food fails, even where a feeling of hunger predominates. In the semi-arid cactus deserts, savannas, dry and pine groves of Mexico, it is useless to look for birds a few hours after sunrise, and the same applies in Australia (Finlayson, 1935). Only toward evening do they again become active. Exceptions prove this rule. The number of eggs of quail which inhabit

the semi-arid regions of Mexico south of the Tropic of Cancer, is not smaller than in the United States. The ability of these birds to store food in the crop makes them independent of high midday temperature. In Caderyta, Queretaro (2100 m. elevation) even the crops of Scaled Quail (*Callipepla squamata*) killed at midday were filled with cactus seeds which had been gathered in the cool hours of the morning. This supply ensures a uniformly continuous metabolism which permits the laying of an egg each day without making demands on the reserve materials. My attention was drawn to their qualities as permanent layers by boys looking after goats in the cactus and stony desert, who brought me a few eggs every couple of days but never a full clutch. Questioning revealed that they always left a few eggs in any nest they found, so as to exploit the ability to lay continuously and increase the yield. Up to the time of my departure one female laid 17 and another 19 eggs, whereas the normal clutch in nearby Hidalgo fluctuated between 10 and 13.

The exceptional behavior, which has often been discussed, of nightjars whose clutch size increases as the latitude decreases, can be accounted for by the possibility of searching for food for a longer period than in the temperate latitudes, owing to the brighter tropical nights. Birds of twilight in the north, in the south they hunt for insects even at night. Why swifts on the other hand produce an equal number of eggs in the United States and in equatorial Brazil is problematic: *Chaetura andrei*, 4 to 5 in Brazil (Sick, 1948), *Chaetura pelagica*, 4 to 5, and *Chaetura vauxi*, 4 to 6 in the United States (Bent, 1940).

The type of food can also be influential. Corn-eating Scaled Quail with their large number of eggs form a contrast to the Spotted Wood-quail (*Odontophorus guttatus*) and Long-tailed Wood-quail (*Dendrortyx leucophrys*) of the cool, tropical moist and mist forests, which live on insects, worms, and other small animals and have clutches of four to six eggs. With the wood-quail the search for food lasts the whole day, so that the general basal metabolism is greater than with the blue quails (*Lophortyx* and *Callipepla*) which rest in the shade for the main part of the day and so have less food material available for the production of eggs.

The difference in composition of the food probably also helps to determine the different numbers of eggs of Ocellated Turkeys (*Agriocharis ocellata*, wt. 2260 g.; 2026 g.) which lay six to eight eggs and the Purplish Guan (*Penelope purpurascens*, wt. 2430 g.) which lay only two. Turkeys, which have a crop, live on seeds (they are fond of raiding maize fields), berries, insects, and young plant shoots, whereas

the stomachs of Mexican guans, *Penelopina nigra*, *Penelope purpurascens*, *Oreophasis derbianus*, and *Crax rubra* which I have examined, were filled with leaves, young shoots, and berries (Wagner, 1953 a and b). It is therefore not surprising that the fleshy turkeys are tasty, whereas the thin guans are dry and stringy. The argument that the extra hazards of turkeys, which nest on the ground, compared with guans, which nest in trees, necessitates a larger number of eggs is untenable, as ground breeders among the guans such as *Penelopina nigra* and *Oreophasis derbianus* do not rear more than two chicks.

To sum up, we can state that in the overall constellation the upper limit of the number of eggs of a brood is fixed genetically. The fertility potential can be reduced by environmental influences as has been proved in numerous experiments in entomology. The effects of external factors are more obvious in the tropics than in temperate latitudes where the birds cannot afford such a close dependence.

In any case, the opinion of Lack (1947a and 1948a) and of Lack and Arn (1947), that the number of eggs in a clutch is generally fixed genetically for the species, is in my opinion not universally valid. The statistically proved differences in propagation of English, Dutch, and Swiss starling and quail populations are probably conditioned by the environment, as are the fluctuations in individual years (Lack, 1947b, 1948b, 1949, and Silva, 1949). The relatively large number of eggs in the clutch which occurs within a population in the spring and the smaller clutches of the second brood are conditioned by the physical constitution and age of the female. This view will appear erroneous to those who cannot give up the idea that slight differences in the reproductive rate are not significant for the preservation of the species. Figures for increases and losses are not as clearly balanced as is often assumed. Otherwise external circumstances could only too easily lead to the extinction of a species. Nature employs a considerable surplus as a safety factor, so as to cope with any possible threats of extermination (Wagner, 1953c) or to bridge the gap caused by the loss of a reproductive period.

Resistance to the environment, which constantly aims at increasing the propagation rate, is less in the seasonally balanced regions of the tropics than in areas with contrasting seasons. To counter unfavorable environmental influences (northern winter, aridity of the desert, etc.), all possible methods of progressive adaptation to the given environmental conditions are adopted to improve the prospects of life for the individual and to increase the propagation rate. Under favorable living conditions this has led to larger broods and clutches,

or in the arid regions of Australia, to the ability to procreate at the age of two months as with the Zebra Finch (*Taeniopyga castanotus*). Thus in the case of the Zebra Finch, an additional generation within a reproductive period helps to bridge gaps created by failure to breed for some time or by the extinction of large swarms where a water-hole dries up and there is no possibility of reaching another (MacGillivray, 1932). In contrast to this, many smaller birds of the damp, warm tropical forests, such as representatives of the thrushes, tyrant flycatchers, finches, swifts, trogons, and other families, do not breed until the age of two years and more. No reason can be given for this late breeding.

Further experiments must show whether the variable clutch size can be accounted for by the preceding conclusions. Only a consideration of the whole problem will enable us to understand correctly a process as complicated as the one we have discussed, while at the same time we should not deceive ourselves that causal explanations are always defective, as we do not and never shall know the conditions well enough to understand them perfectly.

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THE MOLTING PERIODS OF MEXICAN HUMMINGBIRDS

BY H. O. WAGNER

THE molting periods of birds of the temperate latitudes of America are fairly well known, whereas data on the inhabitants of the regions between the tropics are very widely scattered throughout the literature. Details are given only by Dickey and van Rossem (1938) in their work "The Birds of El Salvador."

I know the molting periods of 20 of the 50 species found in Mexico. The periods indicated in Figure 1 will presumably be extended as the records increase. Examination was made of freshly killed birds supplemented by skins from the Biological Institute of the University of Mexico. Only hummingbirds in adult plumage have been considered. Molting in juveniles occurs independently of the season, a few weeks after leaving the nest. Young birds which have undergone this molt shortly before the molting period characteristic of the species do not change their plumage again until the following year. Of eight male Rivoli Hummingbirds (*Eugenes fulgens*) taken at Tepepan, D. F., between April 2 and 25, only the five adults were molting. Seven adult male White-eared Hummingbirds (*Hylocharis leucotis*) collected in Santa Rosa, D. F., October 2 and 5 were molting, whereas five young raised that summer and taken at the same time as the adults showed no blood quills.

The season of annual replacement of the plumage in the hummingbird family is highly variable. Every month, at least one species is in molt (Figure 1). In some species the time of molt of individual populations may not be the same. It thus is tempting to trace the causes that condition them.

Position of the molting period in the annual cycle.—Irregularity in the molting time can be understood only in relation to breeding behavior. As long as a bird is in breeding condition, no shedding of feathers occurs. This makes it necessary to examine more closely the factors which determine the reproductive period. In hummingbirds favorable environmental conditions stimulate the breeding urge at all seasons but unfavorable ones suppress it. No inherited reproductive rhythm can be discovered. The molting period is fitted into pauses between breeding periods conditioned by environmental factors. If, during one of these periods, living conditions deteriorate beyond a certain point, the birds look for areas where conditions are more favorable. Migration and molting may then coincide. If conditions for reproduction are fulfilled in the new site, migration and breeding may occur up to three times in the course of a year

FIGURE 1. Molting periods of Mexican Hummingbirds.

(Wagner, 1943, 1948), although molting occurs only in a pause between nestings.

The more or less fixed regularity of the seasons with their different climates, and therefore of living conditions, can create the illusion that the breeding, and therefore molting rhythm also, is determined by heredity, whereas in fact it is conditioned by the climatic rhythm. This is clearly shown by the irregular distribution of the breeding time within a species throughout the year according to the local weather conditions. Here it is not only the conditions for feeding which are decisive but often the nature of the nesting material at the time as well. Thus moss, a material used frequently in building, is too brittle and dry in the dry season to work on, and so makes nest building and reproduction impossible then.

The White-eared Hummingbirds in the mountains near Mexico City have proved to me on many occasions to what extent local conditions can determine differential behavior even within a population of one species. Those that live in the oak-pine forest—a biological community which is withered and dead in the winter—migrate in November, while those in the neighboring damper fir forest at a higher elevation are permanent residents. Even though blossoms and insects are rare here between December and May, those that remain always manage to find enough spiders and other small creatures in bark cracks, rock walls, and similar places to rear young successfully in spite of the winter cold (below freezing point) and occasional snow up to March when the full effect of the dry season is felt. All the males of this community molt in the autumn, the females do not molt until spring, while according to all indications those that migrate molt in the late autumn.

Females which have started a new brood shortly before the molting period omit the molt if, after the nestlings have become independent, conditions which induce molting no longer obtain. The omission of a single molt is not detrimental to the bird. Its plumage is hardly worn after one year. Freshly molted and adjacent old feathers can often be distinguished only by the intensity of the coloring. The omission of one molt can be recognized later by the increasing abrasion and pronounced fading of the plumage. Exceptional attrition of the pinions and rectrices of individual females of the White-eared (*Hylocharis leucotis*) and Lucifer hummingbirds (*Calothorax lucifer*) captured after the local molting period, can be explained only by the omission of a molting period.

Once molting has commenced, it is completed. If living conditions improve in the meantime, the reproductive instinct can assert itself

again before the completion of molting. One Lucifer Hummingbird whose outermost primaries were still in blood quills was found breeding (Wagner, 1946). Molting males can also be capable of breeding. The diameter of the testes of singing White-eared Hummingbirds in molt was up to 1.8 mm. The corresponding minimum and maximum sizes are 0.2 mm. and 4.2 mm.

In view of the fact that the time of breeding depends so considerably on external factors, it is not surprising that general renewal of plumage of the hummingbirds of the more or less arid plant communities of Mexico usually occurs in the rainless spring months. At this time species like the Lucifer Hummingbird (*Calothorax lucifer*) and the Fork-tailed Emerald (*Chlorostilbon canivetii*) are found looking for food in the flowering trees. On the other hand, the molting period of hummingbirds of the tropical moist and rain forests is in the humid rainy season (summer and autumn) if the reproductive instinct is suppressed.

Hummingbirds generally build bulky nests of plant fibre or moss. Where the humidity is great these materials cannot be worked, as they suck up water like a sponge. It is therefore natural that some species of the moist virgin forest, such as the Emerald-chinned Hummingbird (*Abeillia abeillei*), molt in the rainy period of the summer. This also applies in Chiapas to Rieffer's Hummingbird (*Amazilia tzacatl*) which lives in the same climatic range at the forest edge and in uncultivated clearings, and to the White-bellied Emerald (*Amazilia candida*) which in Yucatan molts in September and October when there is heavy rain.

Frequently, as for example with the Violet Sabre-wing (*Campylopterus hemileucurus*) causal relations are understood only when details of the biology and local weather conditions are known exactly. In the mist forest of the mountains of southern Mexico individuals of this species molt during the coldest season, between October and January. In this biological community it is always moist and rainy, and a condition for its colonization by the Violet Sabre-wing is undoubtedly connected with the type of nest construction. The thinness of the walls of the nest and the type of plant fibres used as building material make it possible for this species to nest in more humid areas and seasons than other hummingbirds. Because they can thus nest in the rainy season, they molt in the inhospitable mist forest, not in the rainiest but in the coldest months when continuous light drizzle is typical.

Molting periods of a species varying with locality.—As the molting period depends so considerably on the reproductive period and hence

on environmental influences, it is not surprising that the behavior of populations of a species in areas where the rainy and dry seasons are not similarly distributed throughout the year, should be correspondingly different. Figure 2 presents data from El Salvador (Dickey and van Rossem, 1938) in addition to those which I obtained from Mexico. Of ten species from Mexico and El Salvador the molting periods of which are known, only three molt in the same months—*Eugenes fulgens*, *Lampornis viridi-pallens*, and *Lamprolaima rhami*. Dickey and van Rossem noticed in a country as small as El Salvador

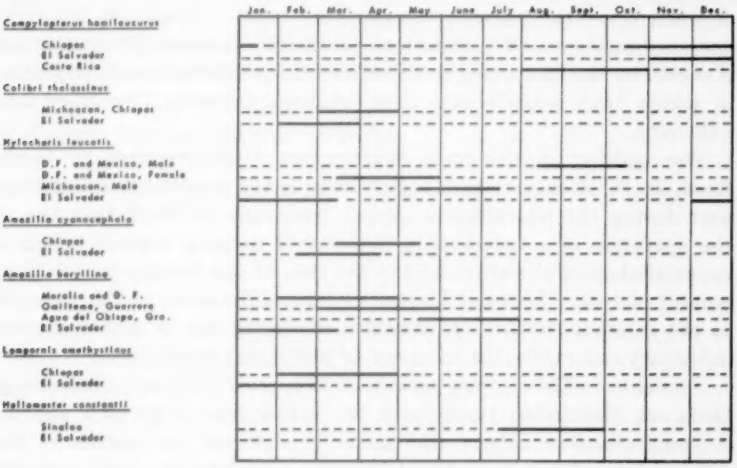

FIGURE 2. Different molting periods of the same species of hummingbirds in Mexico, Costa Rica, and El Salvador.

that there was a difference in the time of molting between the northern and southern race of the Violet Sabre-wing, and also a localized molting period in November or March for the Red-billed Azure-crown (*Amazilia cyanocephala*). Molting twice a year, which was assumed with reservations by these authors, is unlikely.

Different molting times of the sexes.—I have already referred to the surprising discovery that the sexes of the White-eared Hummingbird molt at different times in the vicinity of Mexico City. The males renew their plumage between August and October when living conditions are as favorable as possible. The exact time is not fixed, however, as is shown by three male White-eared Hummingbirds which I collected on 25 June 1947, near Apun, Michoacan, two of which

were molting their primaries. Their molt had begun at the beginning of May before the start of the rainy season. On the other hand, the females, in so far as they are permanent residents, molt in the spring. They are not able to do this in the autumn, as they are fully occupied with breeding. Molting in the females is postponed until unfavorable living conditions cause the breeding instinct to subside. A similar case occurs with the Mallard Duck (*Anas platyrhynchos*) where the onset of the molt of the primaries in the females is dependent upon the state of development of the young, i.e. late brooding females molt later. The time of molt of the drakes, however, depends upon the season (Stresemann, 1934). That this situation does not apply to all populations of the White-eared Hummingbird is shown by the race living in El Salvador, *Hylocharis leucotis pygmaea*, in which both sexes renew their plumage between December and February.

The molting of the male White-eared Hummingbirds of Santa Rosa, D. F., Mexico, which begins when living conditions are at their best during the reproductive period, leads one to think that this is the operation of a hereditarily determined molting rhythm which is counterbalanced elsewhere and in the case of the females by environmental factors. It is not known whether differences in the strength of the internal rhythm or variation in the effects of environmental influences cause different behavior of individual populations.

Summary.—The molting periods of 20 species of Mexican hummingbirds are distributed throughout the entire year (Figures 1 and 2). A comprehensive survey was made to discover the causes of the differential molting time of some species. As long as a bird is breeding, molting is inhibited. The breeding season of humming birds is not controlled by an internal rhythm, as they always proceed to breed every year when living conditions permit. Where living conditions prevent breeding, molting occurs. The effect of fairly regular climatic rhythm can give the illusion of an internal molting rhythm. Populations of a species in adjacent areas do not always molt at the same time. Males and females of at least one species (*Hylocharis leucotis*) can molt at different seasons. In this event the males presumably follow an internal rhythm whereas the females postpone molting to the end of the breeding season.

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GENERAL NOTES

Observations on Fox, Lincoln and Song Sparrows at Jackson Hole, Wyoming.—The generic status of the Fox Sparrow (*Passerella iliaca*), Lincoln Sparrow (*Melospiza lincolnii*) and Song Sparrow (*Melospiza melodia*) has been a subject for debate since Linsdale proposed that all three species be placed in the genus *Passerella* (Univ. Calif. Publ. Zool., 30: 251–392, 1928). Very likely an acceptable solution to this taxonomic problem may result only from a comparative study of the three species. In view of this, it seems worth while to note that all three species are to be found breeding in the willow marshes in Grand Teton National Park at Jackson Hole, Wyoming.

Although the primary purpose of my studies at the Jackson Hole Research Station of the University of Wyoming during the summers of 1952 and 1954 was not the investigation of these sparrows, I made some effort to observe their habitat preferences and habits. Their close association in the willow marshes seemed particularly interesting in view of the hypothesis discussed by Elton (Journ. Anim. Ecol., 15: 54–68, 1946) and others that members of the same genus are not generally found occupying the same niche or exploiting a habitat in the same way.

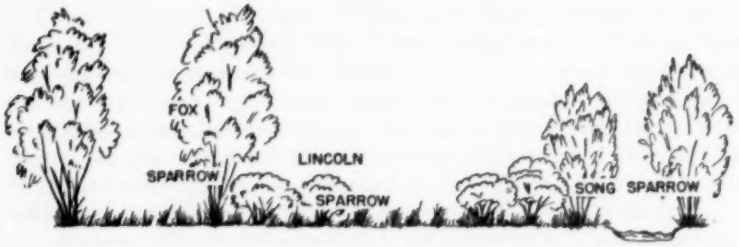

FIGURE 1. Vegetation profile of the willow marsh showing foraging sites of the three species.

The marsh in which the birds were found is directly across the road from the Research Station at Moran. The vegetation of this sort of marsh has been described by Reed (Amer. Mid. Nat., 48: 700–729, 1952). The aspect of the vegetation can best be seen in the accompanying profile (Figure 1) wherein are shown the typical foraging and singing niches of the three species of birds. Basically, the willow growth, which is the dominant vegetation, can be divided into three types according to the height and density of the plants. Along the "stream" courses and where there is open water the plants are extremely crowded and form a dense thicket, six to ten feet high. Here are heard Song Sparrows and here they forage, usually just along the edge of the water, often with their feet in the water. In the drier portions the willows are in low scattered clumps two to four feet high with stretches of sedges and grasses between. In these willows and in the grass are the Lincoln Sparrows. Occasionally, within the drier portions of the marsh, there exists a glade the sides of which are formed by a circle of willows ten to twelve feet high. In the middle of the glade is a grassy opening. The Fox Sparrows sing from these tall willows and feed in the grass of the glade and in the low willows bordering them. The three species are apparently occupying different niches, then, although at times singing within fifty feet of one another.

In terms of relative numbers, the Lincoln Sparrows are the most common. This is to be expected since their habitat covers the greatest area. In some census counts, taken during the latter part of June and the month of July during both years, I obtained the following approximate figures for density, expressed as individuals per ten acres: Lincoln Sparrow 6, Song Sparrow 3, Fox Sparrow 2.

As a further note on the ecological separation of these three species one can derive from Martin, Zim, and Nelson (1951, American Wildlife and Plants) the following estimates for the composition of the diets of the three species during summer months: Lincoln Sparrow, plant food 40 per cent, animal food 60 per cent; Song Sparrow, plant food 60 per cent, animal food 40 per cent; Fox Sparrow, plant food 55 per cent, animal food 45 per cent. Linsdale (*op. cit.*), however, found the diet of Fox Sparrows in western Nevada during May to consist almost entirely of insects. These figures are only a general indication, of course, since they do not necessarily reflect the situation existing at Jackson Hole. They do seem to show, however, that there is only partial overlap in the food habits of the three species.

Of the three species, the Fox Sparrows appear to be the most restricted in type of habitat occupied. I have not found them in any other vegetation-type at Jackson Hole. The Lincoln Sparrow, which one thinks of as a bird of grassy meadows, occurs in such places along the east base of the Tetons. They also occur in the chaparral-like willow scrub on the slopes of the Tetons, although they are not as numerous there as in the marshes. Some are also found in the herbaceous understory of the aspen groves, but these groves are commonly near willows and this occurrence may represent peripheral foraging. Song Sparrows are found wherever there is open water both in the valley, as along the banks of the Snake River, and in the canyons of the Tetons near small streams.—George W. Salt, *Department of Zoology, University of California, Davis.*

Notes on the White-breasted Thrasher.—The White-breasted Thrasher (*Ramphocinclus brachyurus*) is one of the rarest of West Indian birds. Formerly it was much more numerous and widespread, but it has decreased steadily during the past hundred years, with the result that both the Martinique and St. Lucia races are now threatened with extinction.

The Martinique form (*R. b. brachyurus*) appears to be confined at present to the Presqu'île de la Caravelle, an extraordinary peninsula that juts out over five miles into the Atlantic Ocean. For many years thought extinct, this race was rediscovered here in 1950 by Père Pinchon and Marcel Bon Saint-Come (L'Oiseau et Rev. Française d'Ornithologie, 21: 267, 1951). Subsequently a number of "colonies" of *Ramphocinclus* were found on "La Caravelle." I had an opportunity of visiting one of these at Pointe Ferret in January, 1956, in company with Père Pinchon and M. Bon Saint-Come. The birds inhabit semi-arid country, much like the acacia-covered hillsides of southern Martinique, and were found without difficulty by their chattering—a harsh *chek*, or *chek—chek—chek—chek*. No song was heard. In habits they are largely terrestrial and are not particularly shy. As many as five disused nests were located the day I was there, including one that contained fragments of greenish blue eggshell. The nests were comparatively bulky and loosely put together, composed of large twigs and leaves, the inner cup lined with grass and rootlets. They were situated in saplings between 7 and 20 feet above the ground. M. Bon Saint-Come told me that he had found a nest with two young.

The St. Lucian race (*R. b. sanctae-luciae*) is apparently restricted to the northeastern part of that island in the region about Grand Anse and Marquis. I collected *Ramphocinclus* near the latter locality in 1927, encountering it in semi-arid

woodland somewhat denser than that at Pointe Ferret. This thrasher also breeds in colonies in St. Lucia, according to Mr. Stanley John, who collected a nest with two immaculate greenish blue eggs (27 × 19; 25.5 × 19.5 mm.) on June 15, 1954, at Grand Anse. This was situated only 4½ feet above the ground. The eggs resemble those of *Cinclocerthia* and do not agree with the description as given by Thibault de Chanvalon (Voyage à la Martinique, 1763, p. 99), who stated that they are of a "beau bleu céleste, taché à l'un de leurs bouts de petites marques noires," which would apply to eggs of *Saltator*. It is of interest that de Chanvalon refers to *Ramphocinclus* as "le gorge-blanc" (*op. cit.*, p. 180) rather than "gorge-blanche": the species is still known to the natives of both Martinique and St. Lucia as the "gorge-blanc."

As far as I could ascertain, the only other species of Mimidae that at present associate with *Ramphocinclus* are *Mimus gilvus* and *Allenia montana;* but the former prefers more open country, the latter more heavily wooded terrain.—JAMES BOND, *Academy of Natural Sciences, Philadelphia, Penna.*

Displacement Singing in a Canada Jay (*Perisoreus canadensis*).—Few observers seem to have heard the singing of the Canada Jay and, indeed, it probably is of rather rare occurrence. Hence the following may be of interest.

In January, 1956, a Canada Jay came to our feeding-station at Pimisi Bay, Ontario. This bird took to roosting in one of the surrounding conifers and got into the habit of coming down very early in the morning before any of the other birds arrived and I had time to put out any food. Taking advantage of the absence of distractions and the strong urge of the bird to feed at this particular time, I attempted to induce it to come to hand for its first meal. On the second morning when I was thus engaged the jay greeted me with several phrases of *krē* notes, a croaking note repeated quickly three or four times so that it sounds like fits of hoarse mirthless laughter. This is apparently a "scolding" note which expresses an admixture of fear and aggressiveness. Having thus declared itself, the jay showed further reluctance to accept the offering in my hand by making short flights from branch to branch. It finally ended up in a thick spruce where it perched well shielded on all sides except the one from which it faced me. Then the jay commenced singing, giving a continuous sequence of soft notes, most of them distinctly melodious to my ear. The song lasted no less than 30 to 40 seconds and reminded me a little of the Starling's (*Sturnus vulgaris*) continuous notes. Presently shyness overcame the jay altogether and it flew off in search of food elsewhere.

It is obvious that during this episode a conflict arose between two drives which possessed the jay, the urge to feed and the urge to flee, caused by hunger and the finding of food in an "unapproachable" place. The bird reacted by perching at a distance in a "safe" spot, and here it burst into song. This, therefore, was clearly displacement singing.

During an earlier observation (Can. Field-Nat., 61: 7, 1947), I heard another Canada Jay singing under similar circumstances. The bird which I had just released after having banded and examined it, during which procedure it fought violently though in vain, sang a song of considerable length composed of soft whistled notes, standing this time on the ground at a short distance from me.

Dr. Tinbergen (Quart. Rev. Biol., 27: 18, 1952) pointed out the close connection that seems to exist between displacement activities and innate movements that are frequently used; and also that "displacement activities are characteristic of the species, and of the situation" (Proc. Xth Internat. Ornith. Congr. 1950, p. 368).

On two occasions when I have observed some of the courtship and nesting behavior of this species I have not heard any singing in the sense in which it is usually being performed by other passerines during the breeding cycle. It is therefore of further interest to note that singing, here used as a displacement activity, may not be a common activity in the Canada Jay. In relation to the situation, on the other hand, a correlation between the song and the breeding season may be assumed in both cases, although in the first instance no evidence of pairing or beginning courtship had been observed yet in any of the three Canada Jays present in the area at that time.—LOUISE DE KIRILINE LAWRENCE, *Pimisi Bay, Rutherglen, Ontario.*

Winter Returns of Baltimore Orioles (*Icterus galbula*) in the Washington-Baltimore Area.—The return of a winter-banded Baltimore Oriole to Washington, D. C., in at least two out of three later winters shows that this bird was a habitual northern winterer. The appearance of orioles, always of the same sex, at three feeding stations about Baltimore, Md., in two and three successive winters suggests that these birds, also, were the same ones, returned—since this seems less improbable than that different individuals should, in successive years, have happened upon those three particular feeders out of the many that are maintained. It would appear, then, that some number of orioles may now be wintering regularly in the United States, and that the increasing reports of winter orioles do not represent constantly different individuals.

The Washington bird, a male, was first seen as an immature at the home of Ralph E. Lawrence on January 5, 1953, and was banded there on January 7. One of its legs appeared weak; this lameness, in conjunction with its band, made retrappings for later identifications unnecessary. The bird continued to be seen from time to time during the spring of 1953; the dates were not recorded. In the winter of 1953–1954 this oriole was seen at the Lawrence home and the home of E. E. Brown six blocks away, from sometime in October until April 10; on March 22 it was trapped by Mr. Brown and the band number read. In the winter of 1954–1955 it was not seen. In the winter of 1955–1956 it again was present at the Brown home from December 6 to January 9, and at the Lawrence home on several days between February 9 and 15.

In Catonsville, Baltimore County, Maryland (west of Baltimore city) Mrs. Robert E. Costen reported a female Baltimore Oriole at her feeding station from February 10 to April 11, 1955, and again on February 14 and 15, 1956. In Towson, also in Baltimore County but north of Baltimore city, Mrs. George S. Buck had a female on two days around January 24, 1955, again from January 29 to about February 26, 1956, and again from January 15 through January 20, 1957. In the Waverly section of northeast Baltimore a male appeared at the William O. Purcell home on January 14, 1956, and stayed through April 9; on December 11, 1956, a male again appeared there; on December 20 Hervey Brackbill color-banded it and it disappeared, but on January 16, 1957, on the heels of a snowstorm, it returned once more, and was still present as late as January 20.

We express our thanks to Mrs. Robert E. Kaestner and Richard D. Cole, of the Maryland Ornithological Society, for visiting the Waverly and Towson feeding stations in one year or another and confirming the keepers' identification of their birds. The Catonsville bird was not seen by any ornithologist but was described to Brackbill in detail.—RALPH E. LAWRENCE, *1410 Decatur Street, N. W., Washington 11, D. C.*, and HERVEY BRACKBILL, *2620 Poplar Drive, Baltimore 7, Maryland.*

Vestigial Claws on the Wings of a Red-winged Blackbird.—During a recent trip from Madison, Wisconsin, to Regina, Saskatchewan, we saw many dead birds along the highways but stopped to examine only one (during a temporary lull in the traffic). This was on June 20, 1955, a few miles south of Little Falls, Minnesota; the bird was an adult male Red-winged Blackbird (*Agelaius phoeniceus*). Much to my surprise this bird had vestigial wing claws, 2 on the right wing and 1 on the left (see figure). These claws were large enough to be immediately detected. This was the first time I had observed this phenomenon, although I had previously closely examined the metacarpal area for other characters in several hundred Redwings. The claw on the tip of digit 2 on the right wing was parallel to and touching the first primary shaft. It had grown out to one side at the point of contact. It was 4 mm. long (chord). The claw in the similar position on the other wing was 3 mm. in length and projected slightly toward the palmar surface. Both of these claws were oval to triangular in cross-section and gray to black in color. The claw on digit 1 of the right wing was 9 mm. long, pale gray in color and rounded in cross-section. It was nearly parallel to the metacarpal. Upon handling, this claw broke in half, revealing a pointed inner horny core. In the course of further dissection of the claw-tube, two additional pointed cores were found. This suggests a spasmodic or possibly annual growth increment. All three claws were attached directly to the tip of the digits, no bony cores being present. This is apparently the first report of wing claws on an icterid and the third record for a passerine species (see Fisher, Amer. Midl. Nat., **23:** 234–243, 1940). Wing claws have been previously reported for a member of the Tyrannidae (Friedmann, Auk, **69:** 200, 1952) and a corvid (Baumel, Auk, **70:** 373, 1953).—Robert W. Nero, *Saskatchewan Museum of Natural History, Regina, Sask.*

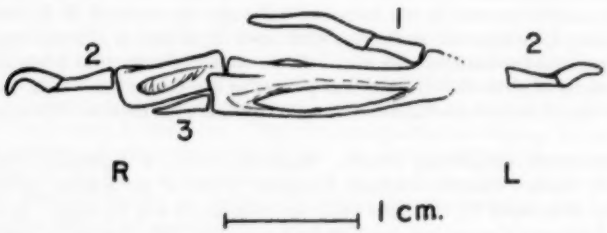

Figure 1. Vestigial Claws on the Wings of a Red-winged Blackbird.

Swallow-tailed Kite in Ohio: A Retraction.—In 1928, I published a sight record of the Swallow-tailed Kite (*Elanoides forficatus*) in Ohio (Auk, 45: 272–273). I have since become convinced that the bird in question was not sufficiently well identified to warrant publication of the record. The bird when seen was perched and was not observed in flight. It was at too great a distance to permit unquestioned recognition of diagnostic features. The observers were then not acquainted with this species in life or in motion pictures. No known specimen of a Swallow-tailed Kite has been taken in Ohio since 1898. Under the circumstances, I feel that the record should be withdrawn.—Robert B. Gordon, *Department of Science, State Teachers College, West Chester, Pennsylvania.*

Bronzed Grackles Feeding on Emerald Shiners.—It has but recently come to my attention that records of the capture of fish by Bronzed Grackles (*Quiscalus quiscula versicolor*) have been published by Townsend (Auk, 36: 627, 1919), Cahalane (Auk, 61: 296, 1944), and Hamilton (Auk, 68: 217, 1951). These records involved the capture of sticklebacks, yellow perch, and alewives, respectively. It therefore seems appropriate to record the capture by Bronzed Grackles of another kind of fish, on the basis of observations that have lain dormant in my field notes for a number of years.

On June 18, 1944, at Niagara Falls, Ontario, opposite the American falls, thousands of slender fish approximately three inches in length formed dense shoals near the surface of the clear water. An occasional dead or dying fish, its white belly turned upward, floated conspicuously at the surface. The shoals were concentrated chiefly below a rocky point and in an eddy at the boat landing. Several Bronzed Grackles walked about on numerous small bits of driftwood floating in the eddy. As I watched, a grackle seized one of the slender fish and flew off, the bright silver body of the fish hanging from the bird's beak.

On several occasions during the next three days, I examined these shoals, and observed that they consisted of fish of a single species. Using a small unbaited hook, I "snagged" 18 specimens (four of which are now deposited in the California Academy of Sciences, under Catalog No. 18611), and identified them as the River Emerald Shiner (*Notropis atherinoides atherinoides* Rafinesque).

During the afternoon of the fifth day, using six-power binoculars, I watched the grackles foraging about the driftwood, and on six occasions saw one carry away a fish that appeared to be an Emerald Shiner.

The diagnostic characters of this shiner have been treated by Hubbs and Lagler (Bull. Cranbrook Inst. Sci., 26: 59, 1947).—W. I. Follett, *California Academy of Sciences, San Francisco.*

A Bronzed Grackle (*Quiscalus quiscula*) Feeding on Live Minnows.—Fish have been recorded as food of Bronzed Grackles (Bendire, C. E. "Life Histories of North American Birds," Washington, 1895; Townsend, Auk, 36: 627, 1919; Calahane, Auk, 61: 296, 1944), but little information is available on the actual feeding behavior involved in acquiring fish. Hamilton (Auk, 68: 213–217, 1951) found that fish, primarily alewives (*Pomolobus pseudoharengus*), occurred in 70.8 per cent of 130 nestlings' stomachs and comprised 6.6 per cent of the total bulk. These alewives were dead ones which the adult birds had picked-up along the shore of Cayuga Lake, New York. Follett (Auk, 74: 263, 1957) observed Bronzed Grackles feeding on the River Emerald Shiner, a fish closely related to the species recorded in this paper.

On July 5, 1956, while the U. S. Fish and Wildlife Service research vessel *Cisco* was docked at Harbor Beach, Michigan, we observed a female Bronzed Grackle taking minnows, probably lake emerald shiners (*Notropis atherinoides acutus*), from the water. A total of seven minnows were taken in a one and one-half hour period. One of the minnows was seen wriggling in the bird's beak, and there seems little doubt that the other minnows were alive also, since no dead ones could be seen floating on the surface. Although there were several grackles in the vicinity, apparently only one was catching minnows since all the fish were captured by a female and taken to the same tree about one-quarter-mile distant. It is probable that these minnows were being fed to nestlings, because we saw none of them eaten by the adult. Further evidence that the fish were being fed to young is that on one occasion, after capturing a minnow, the grackle flew to the dock and rearranged the fish in its beak, then flew out over the water and caught another one.

The procedure which the grackle followed in capturing the minnows was as follows: The bird flew back and forth eight to ten feet above the water, then upon sighting a minnow it dipped down, hovered immediately above the fish and captured it with a quick thrust of the beak. This grackle appeared to be very adept at catching the minnows; it was not observed to miss a capture and got only its breast feathers wet during the procedure.—A. M. BEETON and LARUE WELLS, *U. S. Fish and Wildlife Service, Ann Arbor, Michigan.*

Eastern Phoebes Fishing.—On April 1, 1956, in Jackson Park, Chicago, Illinois, Richard Macomber and I observed two Eastern Phoebes (*Sayornis phoebe*) catching and eating small fish.

The birds were at the edge of a small harbor which is part of a chain of lagoons connected at two points with Lake Michigan. In the immediate vicinity of the birds' activity, the harbor is delimited by a concrete wall rising vertically 25 inches from the water. Behind the wall is a parking area and beyond this, about 25 feet from the water, is a low bank covered with dense bushes.

The two Phoebes were observed for twenty minutes (4:50 P.M. to 5:10 P.M., C.S.T.). During this time, they caught a total of seven fish.

The birds stood on the level top of the concrete wall, peering intently into the water. Suddenly, one would swoop downward. Then one of three things would happen. Either the bird would strike the water immediately at the bottom of its dive; or it would hover for several seconds, two or three inches from the water, and then strike; or it would hover and then return to its perch without touching the water. The only parts of the bird to make actual contact with the water were the upper breast, throat, chin, bill, and forehead.

If the attempt was successful, the bird flew with its catch to the middle of one of the dense bushes. About half the attempts were successful. If unsuccessful, the bird returned to the edge of the wall to resume its watch.

When a fish was caught, it was held by its middle, crosswise in the bill of the bird. Upon reaching a bush, the bird attempted, in one swift motion, to turn the fish in its bill and swallow it head first. Then the Phoebe sat in the bush for one or two minutes before returning to the wall.

Near the wall the water teemed with small, silvery fish from one to three inches long. We were able to see the Phoebes eat only two of the seven fish caught. One was about 1½ and the other about 2½ inches long. The Phoebe which caught the larger fish had a great deal of trouble swallowing its prey, but was eventually successful. Unfortunately, the species of fish was not determined.

Most of the fish seemed to remain two to three inches below the surface. Apparently, the Phoebes caught only those that ventured nearer to the surface. This was evidenced by the fact that the birds sometimes had to scan the water for several minutes before making an attack, and that in catching a fish less than an inch of the total body length of the bird was submerged. The fish caught were apparently alive and active. One was seen to wriggle vigorously as the bird maneuvered it in its bill. I carefully examined the water but could see no floating dead fish.

It is extremely difficult to give a satisfactory explanation for this behavior. It is possible that poor fly-catching conditions forced the birds to change their diet, but weather conditions do not seem to bear out this hypothesis. According to the Chicago Weather Bureau, at 6:00 P.M. (C.S.T.) on April 1, the temperature was 64° F., the relative humidity 44 per cent, and the wind from the southeast at 14 mph. There was no precipitation until 6:56 P.M., about two hours after our observations. The wind was considerably less than 14 mph in the area of observation.

Hence, it would seem that none of these conditions would effect insects in such a way as to hamper the Phoebes in fly-catching.

Once we saw one of the Phoebes fly to the top of a forty-foot tree and commence to fly-catch, only to return to fishing after a few minutes.

Oberlander (Condor, 41: 139, 1939) has observed similar fishing behavior in the Black Phoebe (*Sayornis nigricans*).—LAURENCE C. BINFORD, *University of Michigan Museum of Zoology, Ann Arbor, Michigan.*

***Falco peregrinus* at Sea.**—While aboard a ship crossing the North Pacific Ocean from San Francisco to southern Japan, I was startled one clear morning to observe a falcon approaching from the south. After circling widely about the ship three times, the bird came to rest upon a cable in the upper rigging of the foremast. Our position at eight o'clock that morning, 3 November 1953, when the hawk was first sighted, was approximately 600 miles north by east from Honolulu, Hawaii, more than 500 miles from the nearest land!

From sketches made during the succeeding days and from the bird's size and characteristic activities (I am no ornithologist), it has been identified as an immature Peregrine Falcon, or Duck Hawk (*Falco peregrinus*). How such a bird came to be so far from its known places of habitation is problematical. We had not been experiencing severe winds that might have helped to explain its presence. Once it came aboard, however, it showed no inclination whatsoever to leave the ship, except for brief forays out over the sea to obtain food. From its perch high upon the mast it occasionally dropped and flew swiftly out over the waves to capture small sea birds, which it brought back to the ship and devoured. I was unable to keep a close watch on the hawk, but I did see it catch a bird on 5 November and two more the next day, as we passed within a hundred miles of Midway Island. Again the following day I observed the capture of another small bird; and it may be assumed that the hawk caught several in addition to those seen. Birds eaten included a small, white tern and at least two Bonin Islands Petrels (*Pterodroma leucoptera hypoleuca*). The latter were identified from my sketches and notes by Dr. Deignan of the United States National Museum.

The falcon was last seen on the evening of 10 November, and it is probable that it left the ship during a storm which we encountered early on the morning of the eleventh. By this time, we were about 700 miles off the main islands of Japan, and it may be that the hawk was able to complete its trip in the air. It had remained with the ship for about seven days (The International Date-line must be considered) and for a distance of nearly 3500 miles!

Races of *Falco peregrinus* are known to inhabit both sides of the Pacific, at latitudes at least as far north as British Columbia and Japan and Siberia. However, there is no record of this species in Hawaii, either in G. C. Munro's *Birds of Hawaii* or in Bryan and Greenway's *Contribution to the Ornithology of the Hawaiian Islands*. The latter work lists *Buteo solitarius* as the only Hawaiian hawk, endemic on the island of Hawaii. It records the Marsh Hawk (*Circus cyaneus hudsonius*), as an accidental visitor on Oahu, and the American Osprey (*Pandion haliaetus carolinensis*), as an accidental winter visitor on several islands of the Hawaiian group. Because the transoceanic falcon both came aboard and departed from our vessel at sea, however, it seems unjustified to propose it as an accidental winter visitor in the Hawaiian Islands. Perhaps the range of the Duck Hawk should merely be extended by one record for "North Pacific Ocean, 157° W, 29° N to 148° E, 30° N."—GEORGE W. BYERS, *Division of Entomology, University of Michigan Museum of Zoology, Ann Arbor, Mich.*

Common Tern (*Sterna h. hirundo*) Breeding in the Netherlands Antilles.—The islands of the Netherlands Antilles—Aruba, Curaçao, and Bonaire—are situated in the Caribbean Sea off the Venezuelan Coast.

The only previous breeding records of the Common Tern in the Netherlands Antilles have been from the island of Bonaire, where Hartert found eggs of the species in abandoned flamingo nests in 1892 (Ibis, 1893: 337) and where Rutten saw a single downy chick a few days old in 1930 (Ardea, **20**: 104, 1931).

Annually from 1952 through 1955, we have found loose colonies of two to seven nests on four small islands or groups of islands in the inland bays of southern Curaçao (Isla Makwakoe, Spaanse Water, Nieuwe Haven, and Jan Thiel). Adult birds and eggs have been collected and sent to the Amsterdam Zoological Museum. There Dr. K. H. Voous has identified the birds as specimens of the nominate race, whose only other known tropical breeding ground is off the coast of Nigeria, West Africa.

The eggs average 41 × 29 mm. Their shape is the same as in the northern breeding range, but the color is different, being very light cream, heavily marked with small olive-brown and gray blotches. Complete clutches of one, two, and three eggs have been found, a clutch of two being by far the commonest. Egg dates range from April 26 to August 2.—F. H. Ansingh and H. J. Koelers, *Curaçao, Netherlands Antilles.*

Southernmost Records for the Hooded Merganser (*Lophodytes cucullatus*) in the United States.—On November 8, 1954, three ducks, which I tentatively identified as mergansers, appeared on the rock pit lake in the Long Pine Key Fire Tower area of the Everglades National Park in south Florida. Their silhouetted outlines looked like those of Hooded Mergansers, but they were in too poor light for me to be sure. I saw these same three ducks several times in the next few weeks, and by November 20 I had identified them as the Hooded Merganser.

Part of the time only two ducks were present and were either a pair, or a female and an immature. When there were three, the group was always composed of a male, a female, and an immature. The last behaved in a consistent manner every time it was present. It was a little smaller than the others and remained close to the female, seeming to do everything the female did. It always remained a few inches behind, never swimming abreast of the female, never going ahead. The pair, however, whether on the lake by themselves or with the immature, remained relatively close but moved about independently.

On December 12, 1954, David Karraker, a park naturalist, reported seeing two Hooded Mergansers, a male and a female, in Barnes Pond on Long Pine Key road, which is but two miles from where I had been observing them. Since the birds which I had been watching disappeared for two or three days whenever boy scouts or other campers came in, there is little doubt that the Barnes Pond individuals were also those visiting the rock pit.

On December 16, I recorded in my notes, "The Mergansers were here [at the rock pit] again at dawn, but there are four this time . . . one male, two females, and the immature. The behavior of the immature and one of the females remains the same."

Mr. Daniel Beard, Superintendent of the park, stopped at the rock pit the next day and was amazed to see the four Hooded Mergansers, his "discovery" making me aware of the rareness of this species in this area and leading me to discover that the southernmost records for these birds have not been published. Mr. Charles Brookfield, of Tropical Audubon, Miami, saw a pair of these ducks on a small pond

near Nine-Mile Bend in the park about 7 years ago. On February 7, 1949, Mr. Willard E. Dilley, park naturalist, flushed a pair of Hooded Mergansers on the same pond. Their records, and mine, which have not appeared until now in the literature, constitute the farthest points south for Hooded Mergansers seen in the United States. The only other record for this species in south Florida is that published by Louis A. Stimson, who saw it off the Tamiami Trail in February, 1941. My rock pit mergansers were 40 miles south of Stimson's, and the birds seen by Brookfield and Dilley were about 60 miles south of the Tamiami Trail and only a mile or two, as the crow flies, from the Gulf.

The rock pit mergansers disappeared during the Christmas holidays as a result of an influx of campers. They were very shy birds, taking several weeks to become accustomed to me without flying off as soon as I appeared. As of the latter part of January, 1955, they had not reappeared.

No record exists for Hooded Mergansers in the Florida Keys, and the pond where Brookfield and Dilley saw them is almost on the bottom edge of the continent. Bond (Field Guide to Birds of the West Indies, 1947, p. 44) lists this merganser as a rare winter resident in Cuba. Sprunt reports more of them in Florida than anyone else; in his revision of Howell's 'Florida Bird Life' (1954), he says that he has personally found this merganser to be a regular visitor in small flocks in the ponds of the Kissimmee Prairie, where he says the Audubon trip people see it; but that is well up into the central section of the state.

There are several scattered records for central and northern Florida. Shannon (Fla. Nat., 7: 31, 1934) lists two of these birds shot at Merritt's Island on November 21, 1933. The Christmas 1949 count (Aud. Field Notes, 4: 107, 1949) lists 9 Hooded Mergansers for the St. Marks area in northwestern Florida, and Stoddard saw 11 in the same area on October 26, 1950. Longstreet (Fla. Nat., 26: 186, 1953) calls this duck an unusual species for Florida; he says that he first saw the species in this state, a flock of 7 with one male, on December 4, 1925, though he had previously recorded a possible one near Coronado back in December, 1913. He records several near Port Orange, just south of Daytona, on December 12, 1927, and some males and others near Coronado on January 29 and February 19, 1928. On a field trip with Dr. Witmer Stone, then editor of 'The Auk,' he saw a pair near Wilbur on February 3, 1930. At the same place, in company with Eaton and Savage, he saw three on December 26, 1930. On a Christmas census, in 1936, he saw one male and three females, then he saw no more until coming upon one female on a cypress pond on November 15, 1952.

The only breeding records for Florida are cited by Howell (Florida Bird Life, 1932, p. 158). He states that Brewster reported this species breeding commonly on the Wekiva River in March, 1877. Young about a week old were seen on the St. John's River near Blue Springs on March 28, 1877. On March 3, 1929, Hellman and a companion saw a female in a cypress swamp near St. Augustine. She was shot and several young scattered in all directions. There have been no breeding records for Florida since then, and strangely, there are no definite nesting records for the species according to Sprunt (1954), in Georgia, and only two for South Carolina.

The Hooded Merganser is an uncommon winter visitor in Florida in general and is exceedingly rare in the southern, sub-tropical portion of the state. The presence of four of these birds in the Everglades National Park this past season raises hope that the protection which the park offers them will encourage them to return and to attract others of their kind into the area.—Mary P. Sherwood, *Everglades Natural History Association, Homestead, Florida.*

First Record of Vermilion Flycatcher (*Pyrocephalus rubinus*) in Kentucky.—W. Scott Glore, Jr., and I were duly surprised to find a Vermilion Flycatcher on a farm about one mile northwest of Danville, Boyle County, Kentucky, on October 8, 1955. For half an hour, during this calm, sunny, moderately warm afternoon, we watched the flycatcher actively pursuing a variety of insects near a small willow-bordered pond, 950 feet above sea level.

Realizing that the vagrant should be collected, we made a hurried trip to Danville for the necessary tools, refound the flycatcher, and secured it without difficulty. It proved to be an immature male (testes minute, but skull completely granulated) with chin and throat still mostly white. Vermilion feathers were coming in on the crown and predominated on breast and belly. The bird was apparently in perfect condition, showed no signs of having been in captivity, and was moderately fat (weight 15.2 grams). Its skin was presented to the University of Michigan Museum of Zoology (No. 151,824). Dr. Alexander Wetmore has kindly identified it as *P. r. mexicanus*.

So far as I have been able to find out, the Vermilion Flycatcher has not previously been recorded from Kentucky. Moreover, it seems to be unreported from any of the seven adjacent states, though once taken at Toronto, Ontario (Swift, Auk, 67: 517–518, 1950), fully 500 miles northeast of Danville, which, in turn, is about the the same distance from parts of Louisiana and Florida where it is now of regular occurrence.

As a possible explanation of this bird's presence in central Kentucky, Mr. O. K. Anderson, meteorologist in charge of the United States Weather Bureau Airport Station at Louisville, Kentucky, very kindly sent me the following information: "On October 2nd, a southerly flow of air developed over the southwest and the Southern Plain States. This flow increased in velocity and gradually shifted to the southwest during the next several days, and on the 4th, 5th, and 6th averaged about 30 to 35 knots from the southwest as a cold mass of air, associated with a high pressure area, approached the Kentucky area on the 5th and 6th. The cold front along the leading edge of the cold high pressure area moved across Kentucky on the 7th, preceded and accompanied by showers. The wind shifted to the northwest 25 to 30 knots behind the front and persisted for about 24 hours. It would have been easy for the bird to have flown in from the southwest during the several days preceding the 8th, since winds were rather strong from the southwest and the weather was warm and mostly fair. It may have been grounded on the 7th by the precipitation that accompanied the cold frontal passage. It is quite possible that the bird was in the area 50 to 100 miles northwest of Kentucky when the front passed through early on the 7th, and it may have flown in from the northwest under the overcast behind the front on the 7th and 8th along with northwesterly 25 to 30 knot winds that prevailed for about 24 hours after the frontal passage."

While the weather conditions so well described by Mr. Anderson are likely to have been a potent factor in bringing this bird to Kentucky, another possibility suggests itself. May not the recent multiplication of records in Arkansas, Louisiana, Florida, and Georgia indicate a significant eastward, or even northeastward, extension of the Vermilion Flycatcher's fall and winter range? In this view, the young male here reported might have been an adventurous individual by no means so far beyond the northeastern periphery of the species' range as would have been the case 25 years ago. It may be recalled that as lately as 1931, the A.O.U. Check-List (4th ed., 211) mentioned only one occurrence east of Texas.—Frederick W. Loetscher, Jr., *Centre College, Danville, Kentucky.*

REVIEWS

Days with Birds. Studies of Habits of Some East African Species.—V. G. L. van Someren. Fieldiana, Zoology, vol. 38, 520 pp., 126 photos. 1956.—For many years Dr. van Someren was the leading student of birds resident in Kenya Colony and made very extensive collections, now largely divided between the American Museum of Natural History (whence they came as part of the Rothschild Collection) and the Chicago Natural History Museum. He also made a great many intensive studies of the habits of a large number of species and took thousands of photographs from "hides" or "blinds" set up near their nests. In the present book he limits himself to accounts of 160 species studied in his 40-acre sanctuary at Ngong, near Nairobi. Originally part of a longer manuscript with many more illustrations, the book was written for more general reading in the hope of stimulating interest in the bird life of eastern Africa, especially among the younger settlers in that area. It was not possible to get the larger work published, and it is fortunate that the Chicago Natural History Museum has brought out these detailed first-hand observations that otherwise might never have become available as part of our records of African birds. In many species the data given here are the most extensive of any one source and add significantly to what was in print.

On reading some of the accounts of birds generally considered as poorly known, it comes as something of a surprise to find the author spent many hours daily, often for weeks on end, watching and recording their activities at close range. The accounts at times achieve the degree of itimacy one has come to expect of North American and European life history studies. The excellent photographs of many of the birds are the best, if not the only, ones taken of their respective subjects. Some of them have appeared in the recent two-volume work on East African birds by Mackworth-Praed and Grant.

It may be mentioned that the author had no opportunity to decide on deletions from the original text or illustrations and may well feel disappointment at what may seem to him a partial publication. However, all others interested in African birds will be grateful that so much could be printed in these days of high costs. The thankless job of reducing the manuscript to the final bulk fell to Dr. Austin L. Rand, to whom also fell the task of seeing it through the press. This is an important contribution to African ornithology and will be a continuingly useful reference work.—HERBERT FRIEDMANN.

The Waterfowl of the World.—Jean Delacour, with twenty-four plates in color by Peter Scott, and twenty-nine distribution maps. Volume Two. The Dabbling Ducks. London, 232 pp. Country Life Ltd. 1956.—The second volume of this comprehensive work by Mr. Delacour, with Peter Scott's splendid illustrations, is now out, living up to the first in scope and presentation. This volume encompasses the group that the author calls the dabbling ducks, the mallards, teal, and their kinfolk, and follows the method of classification of the family Anatidae proposed by Delacour and Mayr in 1945 in the 'Wilson Bulletin.'

It is interesting in this connection to compare the systematic treatment of this group with the last great monograph of the ducks, that of Dr. John C. Phillips, published in a more expansive way between 1922 and 1926. Phillips' arrangement of these species consisted of sixty-six species in ten genera, while Delacour's comprises forty-three species in six genera, a reduction of thirty-five per cent and forty per cent, respectively. The difference in the number of species is essentially the result of treating island forms as subspecies instead of distinct species. The reduc-

tion in the number of genera is largely due to a better knowledge of a few rare and previously little-known forms such as Salvadori's Duck or the Auckland Island Duck, which has shown that their being pigeonholed as monotypic genera was hardly worthwhile. In addition, the shovellers, kept as *Spatula* by Phillips, are here lumped in *Anas* by Delacour, simply a mark of consistency in this case. If genera are to be lumped, then the expanded genus should be used sensibly, as a measure emphasizing relationship. Like all such present-day revisions, Delacour's current one creates large, expanded genera, with a few virtually monotypic genera left here and there to take care of the inevitable "aberrant," "primitive," or otherwise curious exceptions, the arrested oddities.

For the moment this volume epitomizes the last word on the dabbling ducks. But, "last year's words belong to last year's language." A new subspecies of Blue-winged Teal has been described this year, too late for discussion in this book. In addition there are bound to be certain points on which doubt still exists and which must await further research and confirmation. Such a point is the status of Oustalet's Gray Duck, considered a full species, *Anas oustaleti*, by Phillips, and relegated to a paragraph, p. 42, by Delacour as a mere hybrid. This bird breeds on Saipan in the Marianas group, and perhaps on islets to the north and south of Saipan. Yamashina, in an interesting article in 'Pacific Science' in 1947, pointed out that a number of his large series of these birds showed evidences of male Mallard (*A. platyrhynchos*) plumage, rather like northern Mallards coming into or going out of eclipse plumage. He suggested that in fact the population was an unstable one, a sort of hybrid swarm, based on descendents of casual Mallards arriving from the north and stray Gray Ducks (*A. superciliosa*) arriving from the islands to the south. If this is so, it is a very interesting case biologically speaking and one which should be thoroughly investigated, for such a "laboratory" case in birds in the wild state is of necessity rare. It is a case which should be signalled, emphasized, rather than minimized as is done in Delacour's text.

In fact, of course, the evidence is not complete as this volume itself shows, for specimens of other island subspecies such as the Kerguelen Pintail and the Hawaiian Duck occasionally show traces of male nuptial plumage of the ancestral form even after long isolation. Finally, if, however, the Marianas Mallard is indeed merely a hybrid as Delacour believes, then it provides a third case of overlap in the breeding ranges of two species of the Mallard group. On p. 56, Mr. Delacour states that there are only two known cases of overlap in the breeding ranges of this group, that of the Mallard with the Black Duck in eastern North America, and with the Spot-billed Duck in northeast Asia.

Each species account in the volume is arranged with a general summary first, then a discussion of each subspecies. Here and there one could wish that a more detailed description of distribution or of characteristics had been given. For example, on pp. 57–59, an interesting new record by Ludlow of the wintering range of the eastern form of the Spotbill in the Tsangpo Valley of Tibet is omitted, a record which would explain the otherwise rather mysterious vagrant status of this form in northeast India. The distribution maps are similarly sketchy in some cases. Especially when the map is of a small geographical area for a limited range, it would seem wise not only to make it very exact, but also perhaps to demarcate the area with explanatory text or geographical place names actually on the map itself. Only the expert presumably could feel at home with the distribution map of *Anas leucophrys* for example on p. 195, or that of *Rhodonessa caryophyllacea* on p. 198. And even here a moderately knowledgeable person might quibble, for the distribution of the

Pink-headed Duck is carelessly drawn, including such areas as the mountains of Nepal and southeast Tibet, where the species presumably never occurred, and omitting Manipur and northern Andhra where it has been known to occur. On p. 107, it seems that Falcated Duck are by no means generally a wintering species in Assam.

In the sections on characteristics there are certain omissions, the most notable one perhaps being the failure on p. 112 to list the principal character of Coues' Gadwall, the increased number of lamellae of the bill. Again certain diagnoses are vague, at least to this reader. I am not clear about the difference between female Widgeon plumage and female Mallard dress being due to the absence of lengthwise markings in the former. Perhaps all authors who know their subject as well as Delacour tend at times to oversimplify, at other times to be didactic. There is a great deal of variation in all sorts of characteristics of ducks, as for example, Terry Jones is quoted as saying about the eggs of shovellers on p. 66. One hen Shoveller lays "sausage-shaped" eggs, another quite rounded. The classical attempts of oologists to arrange species by their egg shapes and colors would be confounded by the plasticity of shape, size, and color of waterfowl eggs. My first set of Philippine Duck eggs, laid in 1950, were rather rounded. I was struck again this past summer of 1956 by the very rounded shape of another clutch of Philippine Duck eggs.

My single Philippine duckling, described in the 'Wilson Bulletin' in 1951, was very dark, much darker than those reared by Scott and Jones later, rather reminiscent of the Falcated duckling shown opposite p. 110, but with reduced spotting. There is a very great variation in the tone of plumage of ducklings, as consultation with Peter Scott's plates of ducklings will confirm. My Chiloë Widgeon never seem to be as palely spotted on the back, as that in the plate facing page 162. Nor are my other baby widgeon as olive-tinted as those on the same plate, nor my Pintail as curiously marked with deep buff and gray on the face. Even a common species like the Gadwall, a well-known duckling plumage, is capable of considerable variety in facial pattern, spotting, and tone of color. A single Gadwall duckling this spring at Litchfield, lacked the facial pattern, the stripe in front of the eye, and the pale edging along the bill, and gave every evidence of being a different species, until it finally lost its downy plumage.

Under general habits there are many interesting resumés of behavior patterns, particularly those quoted from the penetrating studies of Lorenz. To many current students, these discussions will be one of the most valuable parts of these volumes. Even here there is room for variation. On p. 72, the Chestnut-breasted Teal is said never to perform the "grunt" in the "grunt-whistle" display. One of my drake Chestnut-breasted Teal on the other hand always gave an excellent and penetrating grunt at the culmination of the rearing-up display with bent head and neck which produces the whistle.

The colored plates are up to Peter Scott's usual high standard of excellence. The arrangement is such that many of the rare and little-known subspecies of wide-ranging species are also represented in color. Here and there occasional patterns seem slightly overdone. The plate opposite page 46 shows a drake Hawaiian Duck in what must be a somewhat rare plumage, brightly colored with deep rufous breast and greenish head, and curled sex feathers. I have only seen one skin as well-marked as this. Surely the more normal plumage pattern of the male Koloa is hen-feathered, more like the female? In this connection it is worth noting that individual Hawaiian Ducks may have traces of white feathers about the head in the same manner, al-

though more reduced, as the Laysan Duck. Another representation which seems unusual is that of the cock European Widgeon opposite page 118. Here the streak of dark greenish behind the eye seems rather exaggerated, almost like a hybrid between the European and American species. The female European Widgeon in the "reddish" phase seems a bit too red, but this is probably due to the color reproduction process, as is perhaps the somewhat overly dull, "dull" phase of the female Chiloë Widgeon.

One aspect of the book which deserves recognition is the summary of the records of breeding successes in captivity. Rearing wild species in captivity or semi-captivity, the practice of aviculture as it is called, is all too little-known in this country, either among professional ornithologists or among bird lovers or conservationists. Students of behavior, confined to laboratories, tend to begrudge acceptance of results made under semi-wild, not controlled conditions. Bird lovers or conservationists often exhibit a strong emotional response of horror and dislike at the thought of birds even in a semi-confined state.

The aviculturist, the man with the "green thumb," who on occasion can rear and maintain delicate species under captive conditions deserves more credit for shedding light on the family of the waterfowl. It does seem too as if in certain cases of vanishing species, aviculture has become the sole answer to their continuance. The Hawaiian Goose, like the American Buffalo, has proved itself successful in captivity. Far better for our grandchildren to see the relict "Nene" alive, even under confinement, than merely stuffed like the Labrador Duck. Mr. Delacour in this volume makes a plea for the Hawaiian Duck and the Laysan Teal, exhorting us to do something about breeding the species in captivity before it is too late.

This beautiful volume with its mass of lovely plates is a testimonial to the patient work of the author and the illustrator. It is indeed a valuable and rewarding volume and an example for future study.—S. Dillon Ripley.

Louis Agassiz Fuertes.—Mary Fuertes Boynton. Oxford University Press, New York. pp. xviii + 317, with 17 half-tone illustrations. January 26, 1956. Price $7.50.—Although no account of so remarkable a life as that of Louis Agassiz Fuertes could fail to make fascinating reading, this can in no way disparage a masterful piece of editing and of sympathetic commentary by the author, Mary Fuertes Boynton. Incorporating abundant carefully selected excerpts from his correspondence into a concise biographical framework, she has given us a delightfully intimate account of her father's life and character. Beginning with his birth (in 1874) and childhood in Ithaca, New York, we are given glimpses of his parents, the developing interest in birds and in bird painting, his education at Cornell, the launching of his career, his marriage and family life, social activities, and numerous lasting friendships. We follow his travels in many parts of the world and his rise as the country's leading ornithological artist, to his untimely death at a railroad crossing in 1927. Letters and accounts from diverse sources—from family, students, friends, and admirers of all ages and stations—have glowing praise for his genius and personal charm. Many will agree that he was the greatest bird artist of all time. None who read of his life can deny that he was uniquely endowed, with great ability in his special field, and in everything else to which he turned his hand; with boundless vigor and energy to make the most productive use of his singular opportunities; and with a sincerity, humility, love for his fellow man, and eagerness for living, which endeared him to everyone with whom he came in contact.

Louis Fuertes' seems to have been a near-perfect life, "unmarred," with "no youthful error, no grave mistake, no tragic flaw, and though his work might have

gone on to still higher achievement he was spared even the suggestion of a decline." Both Eliott Coues and Abbott H. Thayer, respectively his influential first advisor and his self-appointed teacher, early recognized in him a peculiar gift, such that both considered it inevitable that he should find fame and fortune in the almost unprecedented profession he had chosen for himself. His whole life was directed toward the one goal: to study and collect birds, sketch them in the field, and know them, and so to be better able to portray them in his paintings. In all this he was eminently successful, and the quantity of work he produced is staggering. Yet with all this singleness of purpose, Louis had an interest in everything and time for everyone. From his undergraduate days on, he was in demand as an informal entertainer, story-teller, and lecturer, and captivated audiences of all kinds. To young and old, in Ithaca, he became "Uncle Louis," and folks flocked to his studio, to bring him specimens, ask questions or favors, or just talk with him. He wrote but little of a formal nature, yet in all his writing is a fresh originality, and an all-pervading good humor, that make a lasting impression upon the reader. His personal letters have gems of spelling, phraseology, and metaphor that are peculiarly and delightfully his own.

Among the strongest influences of the artist's youth was his close relationship with Abbott Thayer, and he lived much in the remarkable Thayer household. There is correspondence dealing with Mr. Thayer's offer to tutor Louis in basic principles of painting, with the paintings themselves, and later with the controversy about concealing coloration in animals, aroused by the classic work of Abbott and Gerald Thayer. Fuertes was a staunch supporter of their major concepts and did much to popularize them. By way of passing on his heritage from Thayer, he in turn gave generously of his knowledge and experience to younger artists such as Courtenay Brandreth, Conrad Roland, and George M. Sutton. In correspondence with the latter, as in some of that with Abbott Thayer, are found passages aimed at the very heart of those precepts which can give to a bird portrait its ultimate perfection: knowledge not only of the bird itself, but of light and shadow and their effects upon color, and of the reflections from sky or foliage, upon which is based the skill of the bird artist.

Fuertes' expeditions took him to Alaska, to various parts of the United States, the Bahamas, the Magdalen Islands, and Mexico, to Colombia twice, and finally to Abyssinia. And from each trip we have here in his letters most colorful accounts of the sights and sounds of the region as he found it, of his associates, and of his personal experiences. The reader wishes for more of the accompanying sketches that must have made the original letters even more truly works of art. In his profession and on his travels, Fuertes was intimately associated—in addition to those already mentioned—with Frank M. Chapman, Wilfred Osgood, Vernon Bailey, Allan Brooks, and countless other naturalists and people of note, who figure prominently in the letters and narrative.

Some might wish that more of the concrete material on technique could have been included, or that even more space could have been devoted to the detailed accounts of expeditions. For these, one might sacrifice a little of the personal and of the trivial that has been preserved. Yet all is important to portraying the man as he was, so intensely alive and human; and here lies the real charm of his story. The format of the book is simple and artistic, and the printing good. A number of minor typographical errors, while regrettable, are but a slight distraction. While the half-tone illustrations are excellent, it seems a pity that at least one hitherto unpublished original could not have been reproduced in color. A bibliography,

and an apparently complete listing of important works illustrated by Fuertes, are valuable adjuncts to the text.

Any bird lover or art enthusiast, in fact anyone interested in travel or in familiarizing himself with a truly great personality, will find this book a most satisfying reading experience, as he follows the brilliant fulfillment of Louis Fuertes' life ambitions.—WILLIAM A. LUNK.

Western Bird Songs of Dooryard, Field and Forest.—Recorded by Jerry and Norma Stillwell (Jerry E. Stillwell, R.F.D. 2, Fayetteville, Arkansas).—This is the third long-playing (33⅓ rpm.) phonograph disk produced by the Stillwells from recordings made in the field. The first two (Auk, 70: 223, 1953, and Auk, 72: 101, 1955) recorded songs of eastern and southern species. The present disk covers 68 species and subspecies from widely scattered localities from the Rockies to the Pacific.

As in record no. 2, recordings were often made of the songs of several individuals of species with varying song patterns. Subspecific variation is demonstrated in the White-crowned Sparrow by the songs of the four races; furthermore local variations in the Nuttall's and Puget Sound races are exhibited by sample utterances from different localities within the breeding ranges of these subspecies. Place names are also printed on the cover for many of the other species recorded.

An unusual item is a sequence of calls of the Mearn's Quail, a species whose voice cannot often, if ever, have been caught by the microphone before.

Although there are occasional lapses, the quality of the sound reproduction is for the most part extremely good. The record can be highly recommended as a far more satisfactory means of song identification than printed syllabification or graph illustration. It furnishes therefore an excellent companion to the best field guides. It is hoped that more species will be recorded in the near future.—LAIDLAW WILLIAMS.

The Technique of Bird Photography.—John Warham. (The Focal Press, London and New York), 199 pp. Price, $4.95.—All too often articles and books with titles suggesting instruction in the methods of bird photography devote much more time to anecdotes and ornithological facts than to the ways of obtaining pictures. In this book, however, John Warham, one of Great Britain's most efficient bird photographers, presents in a clear full manner most of the basic techniques. It is essentially a how-to-do-it-book. Advice for the selection and care of cameras, lenses, tripods, and other equipment is thoroughly discussed. Instructions for photographing at nests and feeding stations, with or without flash, for construction and placing of blinds, and for tackling a variety of photographic problems are clearly documented.

Since there are two outstanding field guides to the birds of the British Isles, the last section of this book entitled "A Guide to British Birds" seems superfluous. This is a minor criticism, however, in view of the concrete information offered those interested in trying their patience and skill photographing birds.—ALLAN D. CRUICKSHANK.

RECENT LITERATURE

EDITED BY FRANK McKINNEY

Anatomy and Embryology

Berger, A. J. 1956. The expansor secundariorum muscle, with special reference to passerine birds. Journ. Morph., **99:** 137–168, 9 figs.

Berger, A. J. 1956. The appendicular myology of the Sandhill Crane [*Grus canadensis tabida*], with comparative remarks on the Whooping Crane [*G. americana*]. Wilson Bull., **68:** 282–304.

Glick, B. 1956. Normal growth of the Bursa of Fabricius in Chickens. Poultry Sci., **35:** 843–851.—Maximum bursa size was attained in Barred crosses, White Leghorns, and Rhode Island Reds between 10 and 12, 4½ and 6, and 8 and 11 weeks, respectively—all at an earlier age than previously reported. The bursa of males was larger than that of females during the first 4 weeks after hatching. Bursa weight declined between 4 and 13 weeks, much earlier than previously believed.—P. H. B.

Lucas, A. M., and E. M. Denington. 1956. Morphology of the Chicken liver. Poultry Sci., **35:** 793–806.—Describes and illustrates the shape of the liver and its lobes with an analysis of variation in measurements based on 128, 27-day-old birds from the same hatch and same inbred line.—P. H. B.

Moreng, R. E., and R. L. Bryant. 1956. The resistance of the Chicken embryo to low temperature exposure. Poultry Sci., **35:** 753–757.

Rand, A. L. 1954. Notes on downy plumages of Loons (Gaviidae). Canad. Field-Nat., **68:** 13–15.

Romijn, C., and W. Lokhorst. 1956. The caloric equilibrium of the Chicken embryo. Poultry Sci., **35:** 829–834.

Sibley, C. G. 1956. The aftershaft in jacamars and puff-birds. Wilson Bull., **68:** 252–253.—Galbulidae and Bucconidae.

Behavior

Armstrong, E. A. 1956. Distraction display and the human predator. Ibis, **98:** 641–654.—It is concluded that distraction display has developed by the discriminating elimination of nest contents of inadequate performers by predators other than man.—R. F. J.

Blest, A. D. 1956. Protective coloration and animal behaviour. Nature, **178:** 1190–1191.—". . . statements concerning the sensory capacities of animals . . . based on experiments involving the elicitation and measurement of responses from whole organisms, are only meaningful in terms of the precise experimental situations employed."—H. C. S.

Boyd, H. 1953. On encounters between wild White-fronted Geese in winter flocks. Behaviour, **5:** 85–129.—In *Anser a. albifrons*, counts of aggressive contacts relate the success of such encounters to the status of the birds involved. Two ranking systems are shown: 1. parents > paired adults > juveniles in families > single adults > unattached juveniles, 2. large families > smaller families. "The patterns of aggressive and submissive behaviour are described and classified by intensity. A direct relation between intensity of threat and response is found. Though the aggressive postures used by adults and juveniles are similar, adults are more vigorous than juveniles, and parents are more vigorous than adults without families." Factors producing conflict are: sexual rivalry, interference with freedom of movement, and preservation of family coherence.—F. M.

DILGER, W. C. 1956. Hylocichlid Thrushes in captivity with notes on their behaviour. Avicultural Mag., **62**: 183–189.—A brief but valuable description of activities such as sleeping, bathing, pellet casting, defecation, and comfort movements in adult and young thrushes.—F. M.

GOODWIN, D. 1955. Some observations on the reproductive behaviour of Rooks. British Birds, **48**: 97–105.—Nest building movements are apparently stereotyped, but in the early stages there is a reluctance to let go of a placed stick, lest it drop. Some male corvids can build nests but it seems that the presence of a female also doing so may be a necessary stimulus. Goodwin suggests that there is an innate attacking reaction to the sight of other rooks copulating, as Heinroth (1948) found in pigeons. These attacks occur even upon paired birds. Any intruding male who finds himself on top of the female during such an attack attempts to copulate. Once the female again finds a perch she is treated as a "territory owner" and the intruders depart. Evidently a sitting female is not so regarded; hence attempts at rape may occur. There is a discussion of attacks on avian cripples. A motivation similar to human "indignation" is suggested. It is absent in the mate of the cripple. The nesting of an unpaired female (disfigured) is discussed.—M. T. M.

HALDANE, J. B. S., and H. SPURWAY. 1956. Imprinting and the evolution of instincts. Nature, **178**: 85–86.

HINDE, R. A. 1953. The conflict between drives in the courtship and copulation of the Chaffinch. Behaviour, **5**: 1–31.—Observations on captive birds are described in detail. Threat displays are most frequent in situations where conflict between attack and escape tendencies is great. The male dominates the female in winter, but this situation is reversed in the breeding season, when the male's aggressiveness is reduced by his sex drive. "The male's displays occur in those situations where his tendencies to approach (court) and flee from the female are in approximate balance. The intensity of the displays depends on the intensity of the conflict. A similar analysis can be applied to the behaviour of the female."—F. M.

KLOPFER, P. H. 1956. Comments concerning the age at which imprinting occurs. Wilson Bull., **68**: 320–321.—Artificial selection may have modified the behavior of domesticated birds and produced variations in the sensitive periods.—J. T. T.

MARLER, P. 1955–56. Studies of fighting in Chaffinches (1) Behaviour in relation to the social hierarchy. (2) The effect on dominance of disguising females as males. (3) Proximity as a cause of aggression. Brit. Journ. Animal Behaviour, **3**: 111–117, 137–146; **4**: 23–30.—The results of these detailed quantitative studies cannot be fully summarized. (1) Counts of aggressive encounters during winter among the birds in two captive flocks showed that there were straight-line, peck-right hierarchies with males dominant over females. The status of each bird was constant regardless of location of the encounter. When the birds were starved it was shown that males were more tolerant of females than of each other. (2) Females, with underparts dyed red, in imitation of the male, won the great majority of aggressive encounters with normal females, and dominated them in the hierarchy. Dyed females, which had been isolated from males for several weeks, won more fights against males than did uncolored females. The red breast of the male acts as a social releaser, inducing an innate tendency to avoid other Chaffinches. (3) Experiments with movable feeding hoppers were designed to measure the distance at which attacks occurred in winter. Around each bird lies a zone within which the probability of aggression increases. Among the

factors influencing this individual distance are sex recognition (by the red breast of the male), behavior (birds behaving submissively are allowed to come closer), and individual characteristics.—F. M.

MOYNIHAN, M. 1953. Some displacement activities of the Black-headed Gull. Behaviour, **5**: 58–80.—A quantitative study of displacement nest-building and preening during incubation. These activities increased in frequency when 1, 2, or 3 eggs were taken from the nest, being most common when 3 eggs were removed. These displacement activities result from thwarting of the incubation drive. Nest-building and preening are thought to be true "alternative" displacement activities.—F. M.

MOYNIHAN, M., and M. F. HALL. 1954. Hostile, sexual, and other social behaviour patterns of the Spice Finch (*Lonchura punctulata*) in captivity. Behaviour, **7**: 33–76.—The gregarious tendencies of this well-known cage-bird influence many of its behavior-patterns, and the authors suggest that there is a "flocking" drive in this species. There was no evidence of a dominance hierarchy in captive birds. Clumping (roosting in contact with other birds) and social preening are highly developed. There are few ritualized "displays," the plumage is sombre, and the voice weak. It is concluded that selection has not favored the evolution of elaborate hostile signals, and this is thought to be a specialized rather than a primitive condition. The Spice Finch's "Jingle" is not a true song (in the sense of a vocalization which repels males and attracts females of the same species). It is suggested that there is an independent "Jingling tendency." The behavior associated with copulation is discussed in terms of the simultaneous activation of tendencies to attack, escape, and behave sexually, and in the male the further tendency to "Jingle."—F. M.

PRECHTL, H. F. R. 1953. Zur Physiologie der angeborenen auslösenden Mechanismen I. Quantitative Untersuchungen über die Sperrbewegung junger Singvögel. Behaviour, **5**: 32–50.—(From English summary.) A quantitative analysis of the factors affecting the gaping reactions of the young of five species of finch, Nuthatch, Spotted Flycatcher, and Swallow. "In those species of seed eating birds examined the intensity and duration of the discharge of a single gaping reaction is dependent upon the kind and not upon the intensity of the stimulus. The all-or-none-rule must be applied. In insect eating species the duration and intensity of the reaction is dependent upon the strength of the stimulus." Further conclusions, which throw light on the Innate Releasing Mechanism, are reported.—F. M.

RAMSAY, A. O. 1953. Variations in the development of broodiness in fowl. Behaviour, **5**: 51–57.—The maternal behavior of Cochin Bantam hens developed slowly in four stages: brooding, titbitting, clucking, and normal broody behavior. Experiments indicated that socially dominant hens were slower to accept chicks than the less aggressive hens. Hens confined with Mallard ducklings proceeded from stage to stage more rapidly than hens kept with chicks.—F. M.

RAMSAY, A. O. 1956. Seasonal patterns in the epigamic displays of some surface-feeding ducks. Wilson Bull., **68**: 275–281.—From September to April the frequency of different displays, which are described, of *Anas platyrhynchos*, *Anas rubripes*, *Anas carolinensis*, and *Chaulelasmus streperus* varied; the periods of maximum display of the different species did not correspond. A few notes on other species are included.—J. T. T.

SIMMONS, K. E. L. 1955. The significance of voice in the behaviour of the Little Ringed and Kentish Plovers. British Birds, **48**: 106–114.—Part of Simmons' important work on the behavior of the plovers. Eight notes are described for

the adult, and two for the flightless chicks, of *Charadrius dubius*. There are a few remarks on the calls of *C. alexandrinus*. Studies of voice support the conclusion that sexual displays show elements of both escape and attack motivations in the Charadriformes.—M. T. M.

WILLIAMS, C., and W. H. MCGIBBON. 1956. An analysis of the peck-order of the female Domestic Fowl, *Gallus Domesticus*. Poultry Sci., **35**: 969–976.—Four breeds were studied. A linear peck-order rather than triangular was characteristic of the females of this study. No changes in peck order were observed as a result of implantation of gonadal hormones.—P. H. B.

WOOD-GUSH, D. G. M. 1955. The behaviour of the domestic chicken: a review of the literature. Brit. Journ. Animal Behaviour, **3**: 81–110.

ZIRRER, F. 1956. The Great Horned Owl. Passenger Pigeon, **18**: 99–109.—Some unusual observations of the behavior of the Great Horned Owl (*Bubo virginianus*) by a Wisconsin naturalist over a 20-year period.—R. W. N.

DISEASES AND PARASITES

CARRIKER, M. A., JR. 1955. The Ischnocera of the Trogonidae. Novedad. Colomb., **2**: 87–100. Univ. del Cauca.—Mallophaga of the trogons, with descriptions of new forms.—E. E.

CLARKSON, M. J. 1956. Experimental infection of turkey poults with *Eimeria adenoides* (Moore and Brown, 1951) isolated from a natural case in Great Britain. Nature, **178**: 196–197.

EDWARDS, G. R. 1955. Excrescences about the eyes and on the legs and feet of Dunnocks. British Birds, **48**: 186–187.—Such excrescences have been reported before from *Prunella modularis*. In this case a number of infected birds was trapped and the infection was evidently of short duration. One bird infected in August was retrapped, quite free of it, in December. There is an editorial note suggesting a virus as causative agent.—M. T. M.

JUDD, W. W. 1954. Insects collected from birds' nests at London, Ontario. Canad. Field-Nat., **68**: 122–123.

DISTRIBUTION

BALL, S. C. 1954. Additional birds from eastern Gaspe. Canad. Field-Nat., **68**: 103–109.

BANFIELD, A. W. F. 1953. Notes on the birds of Kluane Game Sanctuary, Yukon Territory. Canad. Field-Nat., **67**: 177–179.

BANFIELD, A. W. F. 1953. Additions to the list of Banff National Park birds. Canad. Field-Nat., **67**: 179–180.

BANFIELD, A. W. F. 1954. Notes on the birds of Jasper National Park, Alberta. Canad. Field-Nat., **68**: 9–10.

BANFIELD, A. W. F. 1954. Further notes on the birds of Banff National Park, Alberta. Canad. Field-Nat., **68**: 182.

BENSON, C. W. 1956. New or unusual records from northern Rhodesia. Ibis, **98**: 595–605.

BRECKENRIDGE, W. J. 1955. Birds of the lower Back River, Northwest Territories, Canada. Canad. Field-Nat., **69**: 1–9.

BULLETIN OF THE MAINE AUDUBON SOCIETY. Name changed to *Maine Field Naturalist* beginning with volume 12, 1956. Change results from joint publication with Portland Society of Natural History and inclusion of articles on groups other than birds.—L. M. B.

CARRIKER, M. A., JR. 1955. Notes on the occurrence and distribution of certain

species of Colombian birds. Novedad. Colomb., **2**: 48–64. Univ. del Cauca.—Adds certain species and subspecies to the Colombian avifauna, indicates range extensions and corrections for others.—E. E.

CHAPMAN, E. A., and MCGEOCH, J. A. 1956. Recent field observations from Iraq. Ibis, **98**: 577–594.

DAVIS, W. F. 1953. Birds observed on a canoe trip in northern Manitoba. Canad. Field-Nat., **67**: 148–154.

GODFREY, W. E. 1954. The Cattle Egret at sea off Newfoundland. Canad. Field-Nat., **68**: 139–140.

HANDLEY, C. O., JR. 1956. The northernmost nesting of the Rough-legged Hawk in North America. Wilson Bull., **68**: 246–248.—Nest with two eggs of *Buteo lagopus* on Prince Patrick Island, Canada.—J. T. T.

HÖHN, E. O. 1955. Birds and mammals observed on a cruise in Amundsen Gulf, N. W. T., July 29th—August 16th, 1953. Canad. Field-Nat., **69**: 41–44.

HOUSTON, S. 1956. The Caspian Tern in Saskatchewan—with first nesting record. Blue Jay, **14**: 116–117.

KENNEDY, P. G., (and Editorial). 1955. Royal Tern in Dublin: A New British Bird. British Birds, **48**: 116–117.—A decomposed specimen of *Sterna maxima* was found on the shore near Dublin on 24th March 1954, the first record for Europe. Its condition and site of discovery suggest that the bird died close to where it was discovered. Oceanographic studies show that Dublin is an unlikely area for a trans-Atlantic (Gulf Stream-carried) bird to be deposited. Floating objects from further south would get trapped on the south-western coasts. Though there are populations in Africa as well as America it seems that this was a genuine vagrant.—M. T. M.

MOWAT, F. M., and A. H. LAWRIE. 1955. Bird observations from southern Keewatin and the interior of northern Manitoba. Canad. Field-Nat., **69**: 93–116.

NEW HAMPSHIRE BIRD NEWS. **8** (1955), pp. 3–130; **9** (1956) pp. 3–126.—Each issue contains a report of the season's field records, arranged by species. "A List of the Birds of New Hampshire" is concluded, with a supplement covering exterminated and accidental forms (vol. 9, no. 4) bringing the total list to 350 forms. Short notes primarily of local interest round out each issue.—L. M. B.

PACKARD, C. M. 1956. Holboell's Grebes wintering in Maine. Me. Field Nat., **12**: 40–41.—Regularly occurring winter flocks of 25–125 birds in the area between Biddeford Pool and Cape Neddick, York County, seem to constitute a "center" for wintering. They scatter during the day but raft up in late afternoon.—L. M. B.

SHEPPARD, R. W. 1954. Phalaropes at Niagara Falls. Canad. Field-Nat., **68**: 137–138.—Several autumnal records of the Red Phalarope (*Phalaropus fulicarius*) and Northern Phalarope (*Lobipes lobatus*).—R. W. N.

SUTTON, G. M., and D. F. PARMELEE. 1956. On certain charadriiform birds of Baffin Island. Wilson Bull., **68**: 210–223.—Twenty species and the habitat are discussed.—J. T. T.

SNYDER, L. L. 1954. On the distribution of Colymbus grisegena holböllii. Canad. Field-Nat., **68**: 41–42.—Evidence is presented for decreasing the described breeding range of this species ". . . by approximately thirty per cent."—R. W. N.

TABER, W. E. 1955. The Isles of Shoals. Bull. Me. Aud. Soc., **11**: 58–66.—A brief historical sketch of the islands is followed by a comparison of the author's observations of bird abundance with the records of previous writers.—L. M. B.

TABER, W. 1956. Pelagic peculiarities of the Gulf of Maine. Me. Field Nat., **12**: 73–76.—Circular currents with speeds up to 2 knots over the shoal waters of

the continental shelf may provide excellent feeding places for pelagic species and explain the rare occurrence of these species closer to land. Such currents and shoals are described.—L. M. B.

VON SNEIDERN, K. 1955. Notas ornitológicas sobre la colección del Museo de Historia Natural de la Universidad del Cauca. Novedad. Colomb., **2**: 35–44.—Birds in the above-named museum previously unrecorded or little known in Colombia; among them *Cypseloides fumigatus rothschildi* (= *major* auct.), identified by Wetmore. [The previous Colombian record of this southern species (Novedad. Colomb., **1**: 14) proves to be *C. cryptus, fide* Wetmore *in litt.* E. E.] *Ciccaba virgata occidentalis*, new subspecies.

WALKINSHAW, L. H. 1956. Some bird observations in the northern peninsula of Michigan. Jack-Pine Warbler, **34**: 107–117.

WETMORE, A. 1955. Further additions to the avifauna of Colombia. Novedad. Colomb., **2**: 45–47.—Range extensions into Colombia. *Catharus fuscater opertaneus*, new subspecies.—E. E.

YOCOM, C. F. 1956. Re-establishment of breeding populations of Long-billed Curlews in Washington. Wilson Bull., **68**: 228–231.—*Numenius americanus*, extirpated once from many areas of eastern State of Washington by human settlement, has become re-established where land has returned to pasture.—J. T. T.

ECOLOGY AND POPULATION

ARNOLD, J. W. 1953. Breeding-bird census 1952. Canad. Field-Nat., **67**: 180–181.—Nine species were found breeding in a deciduous woodland of approximately 15 acres in Quebec.—R. W. N.

BEER, J. R., L. D. FRENZEL, and N. HANSEN. 1956. Minimum space requirements of some nesting passerine birds. Wilson Bull., **68**: 200–209.—The available nesting space for birds breeding on small islands in northern Minnesota lakes was determined from the area of each island and the number of resident pairs of each species: *Melospiza melodia*, *Dendroica petechia*, and *Vireo olivaceus*. The least area occurred in cases of one pair per island and was considerably less than the minimum territory reported for each species from studies on the mainland. The minimum area increased with the number of pairs per island until three to five pairs were present, when the area approximated that from mainland studies. There follows a concise and interesting discussion of the possible functions of territorial behavior.—J. T. T.

COTTAM, C. 1956. Uses of marking animals in ecological studies: marking birds for scientific studies. Ecol., **37**: 675–681.—Description of methods, history of bird-banding, and objectives.—S. C. K.

DILGER, W. C. 1956. Adaptive modifications and ecological isolating mechanisms in the thrush genera *Catharus* and *Hylocichla*. Wilson Bull., **68**: 171–199.—*Hylocichla mustelina*, *Catharus fuscescens*, *C. guttatus*, *C. ustulatus*, and *C. minimus* (the last four formerly classified in *Hylocichla*) typically overlap each other in that order from south to north. Competition appears to be reduced by an alternation of terrestrial feeding niches with arboreal feeding niches, and partially, of forest edge with forest interior habitats. Correlations are made between foraging habits and leg and jaw proportions. The course of evolution of these differences is hypothesized.—J. T. T.

EMLEN, J. T., JR. 1956. Juvenile mortality in a Ring-billed Gull colony. Wilson Bull., **68**: 232–238.—In a colony of *Larus delawarensis* in Michigan there was a loss of about 1.5 chicks per territory, mostly as a result of the killing of wandering chicks by terrestrial adults, and a fledging of 0.67 chicks per territory.—J. T. T.

EMLEN, J. T., JR. 1956. A method for describing and comparing avian habitats. Ibis, **98**: 565–576.—A tested, quantitative method for describing significant characteristics of vegetational canopy, screening efficiency, foliage type, nature of twigs, area coverage and dispersion, topography, water, soil, and culture is presented. Some methods of using such data are indicated.—R. F. J.

HILLABY, J. 1956. Death of flamingoes in the Camargue. Nature, **177**: 1247.—Between 2000–3000 estimated to have perished from cold weather in February, 1956.—H. C. S.

JOHNSGARD, P. A. 1956. Effects of water fluctuation and vegetation change on bird populations, particularly waterfowl. Ecol., **37**: 689–701.—Most bird species adhere to a pothole type or vegetation stage of succession. Changes caused by fluctuating water levels result in a redistribution of bird populations throughout the area (Grant Co., Washington).—S. C. K.

MORLAND, T. F. T. 1955. Bird breeding census, 1953. Canad. Field-Nat., **69**: 25.—Twenty-two species were found breeding in a deciduous forest of 19 acres in Quebec.—R. W. N.

SOLOMONSEN, F. 1955. The food production in the sea and the annual cycle of Faeroese marine birds. Oikos, **6**: 92–100.—Correlates plankton production and life-cycles of marine birds.—S. C. K.

GENERAL BIOLOGY

BROOKS, M. 1956. Winter foods of Evening and Pine Grosbeaks in West Virginia. Wilson Bull., **68**: 249–250.—*Hesperiphona vespertina* and *Pinicola enucleator*.

FOWLE, C. D., and A. M. FOWLE. 1954. Observations at a Whip-poor Will's nest. Canad. Field-Nat., **68**: 37–39.—Observations at a nest of a Whip-poor Will (*Caprimulgus vociferus*) in Ontario yielded information on the nest site, incubation, development of the young, and behavior of the young and adults.—R. W. N.

FRITH, H. J. 1956. Breeding habits in the Family Megapodiidae. Ibis, **98**: 620–640.—Egg sites are composed of mounds of vegetable material and soil (*Megapodius, Aepyodius, Tallegallus*), vegetable material covered with soil (*Leipoa*), vegetable material alone (*Alectura*) or are holes in sand (*Megacephalon, Eulipoa?*). Eggs are warmed by solar (or volcanic) heat (*Megacephalon, Eulipoa*, and some *Megapodius* and *Leipoa*), fermentation heat (*Alectura, Tallegallus, Aepyodius*, and some *Megapodius*), or solar plus fermentation heat (most *Leipoa* and *Megapodius*).

Mound temperatures are regulated by the birds to around 90° to 100° F. Mounds are uncovered and covered, releasing excess heat or warming surfaces, thus maintaining desired temperatures; in some species at least the bare head and neck are used as thermometers to test interior temperatures. In *Leipoa* and *Alectura*, clutch-size (total eggs per season) is around 18 to 24 eggs; this is determined by the length of the season. Incubation period is variable, but in *Leipoa* is about 57 days. The breeding season in the mound-building types is coincident with an environment favorable to incubation of eggs. In *Leipoa* the cessation of breeding may be related to selection operating on adults through the food supply: when food becomes scarce there is not enough time each day for adults to forage and still attend to the exacting duties at the mound.—R. F. J.

FRITH, H. J. 1956. Temperature regulation in the nesting mounds of the Malleefowl, *Leipoa ocellata* Gould. C. S. I. R. O. Wildlife Research, **1**: 79–95.—By means of recording instruments it is shown that incubation is largely achieved

by heat generated by the fermentation of organic matter. "By manipulation of the covering soil the birds keep the temperature within the range at which egg development takes place. The principal activity is designed to keep the mound temperature down. Towards the end of the season the heat from the sun becomes important, and at the end of the season active steps are necessary to increase the amount of heat reaching the eggs from this source."—F. M.

HAVERSCHMIDT, F. 1956. The nest and egg of *Tachyphonus phoenicius*. Wilson Bull., **68**: 322–323.—The Red-shouldered Tanager of northern South America.—J. T. T.

HILPRECHT, A. 1956. Höckerschwan, Singschwan, Zwergschwan. Die Neue Brehm-Bücherei, A. Ziemsen Verlag, Wittenberg Lutherstadt. 3.75 DM. 151 pages, 47 photographs, 12 figs.—This monograph on the Mute Swan (*Cygnus olor*), Whooper Swan (*C. cygnus*), and Bewick's Swan (*C. bewickii*) will prove a most useful work of reference. Among the subjects dealt with are distribution, molt, size and weight, breeding biology, food, and migration. There are many interesting photographs and a five-page bibliography.—F. M.

LACK, D. 1956. Further notes on the breeding biology of the swift *Apus apus*. Ibis, **98**: 606–619.—Inception of breeding is earlier, clutch- and brood-size higher, nestling periods shorter, nestling growth rate more rapid in fine (sunny) as compared with poor (wet) summers. Large brood-size is of deleterious influence on nestling survival only in wet summers. There is a general positive correlation between abundant and accessible food and fine summers.—R. F. J.

LOUGHREY, A. G., and R. H. STINSON. 1955. Feeding habits of juvenile Ring-necked Pheasants on Pelee Island, Ontario. Canad. Field-Nat., **69**: 59–65.—Analysis of 251 full crops of juvenile Ring-necked Pheasants.—R. W. N.

MEANLEY, B. 1956. Foods of the Wild Turkey in the White River bottomlands of southeastern Arkansas. Wilson Bull., **68**: 305–311.—The principal foods secured by *Meleagris gallopavo silvestris* in three separate habitats were determined by analysis of droppings and of crop contents. Fruits and seeds were most important.—J. T. T.

MONROE, B. L., JR. 1956. Observations of Elegant Terns at San Diego, California. Wilson Bull., **68**: 239–244.—Observations on plumage, behavior, etc., of *Thalasseus elegans*, which is increasing in numbers in southern California.—J. T. T.

MURIE, A. 1956. Notes on the nesting of the Wandering Tattler. Wilson Bull., **68**: 323–324.—Descriptions of the nest and of the behavior of adults with young of *Heteroscelus incanus*.—J. T. T.

SNOW, D. W. 1955. The abnormal breeding of birds in the winter of 1953–54. Brit. Birds, **48**: 120–126.—In the British Isles, temperatures were consistently above the mean at the end of November and beginning of December, 1953. "Freak" breeding of resident species (Blackbird, Song Thrush, Robin, Starling, House Sparrow, Dunnock, and Skylark) was widespread, though on a small scale. Calculated dates of the first egg show that 23 of 34 clutches were begun in the second half of November and first half of December. Some clutches were started in early November. Of 27 nests of Blackbird, Song Thrush, and Robin, young were hatched in 9. Breeding seems to have arisen from the failure of the usual seasonal decline in temperature from October through December. Reasons for a regular autumn breeding period not becoming established in warmer climates are discussed.—M. T. M.

STONEHOUSE, B. 1956. The King Penguin of South Georgia. Nature, **178**:

1424–1426.—This original investigation gives much information on the breeding cycle of *Aptenodytes patagonica*. It is found that the cycle lasts longer than a year and typically two chicks are raised every three years.—H. C. S.

WARREN, E. F. 1955. The Fledging of a brood of Ravens. British Birds, **48**: 172–175.

MIGRATION AND ORIENTATION

BAILLIE, J. L. 1955. On the spring flight of Blue and Snow Geese across northern Ontario. Canad. Field-Nat., **69**: 135–139.

BROEKHUYSEN, G. J. 1956. Moult adaptation in relation to long-distance migration. Nature, **178**: 489–490.—A high percentage of swallows (*H. rustica, D. urbica*) had molting flight feathers at Cape Town in April, the time when they leave south Africa for northern breeding quarters.—H. C. S.

CARRICK, R., and N. TURNBULL. 1956. Second annual report of the Australian bird-banding scheme, July 1955 to June 1956. C. S. I. R. O. Wildlife Research, **1**: 114–130.—"The large-scale movement of young giant-petrels, *Macronectes giganteus* (Gmelin), from Heard Island and Macquarie Island is confirmed, and it is also shown that these birds remain in lower latitudes into their second year. There is a wide dispersal of crested terns [*Sterna bergii*] (13 records) and silver gulls [*Larus novae-hollandiae*] (66 records) from their breeding places, mainly northwards especially in the case of the gulls in eastern Australia."

DICKENS, R. F. 1955. The passage of Black Terns through Britain in Spring 1954. British Birds, **48**: 148–169.—In each of the years 1946, 1948, 1949, 1950, and 1954 a heavy spring passage of *Chlidonias niger* passed through Great Britain. The earlier ones have been reported on in British Birds. The largest passage of all was in 1954. Direction of flight was between east and north-eastwards. Movements are preceded by a rise in temperature in the Bay of Biscay; they take place in the face of east or north-easterly winds over Britain. In 1954 Black Terns may have been carried west of the normal routes by lateral easterly winds in the Biscay area, as in other peak years.—M. T. M.

FOBES, C. B. 1956. Weather fronts and migration, April 3–6, 1956. Me. Field Nat., **12**: 71–73.—A number of "earliest arrival dates" established during this period are attributed to low pressure and cold front over the middle U. S. and high pressure and warm front over the Atlantic creating a northward flow of warm moist air on which the birds moved into southwestern Maine.—L. M. B.

JAMES, P. 1956. Destruction of warblers on Padre Island, Texas, in May 1951. Wilson Bull., **68**: 224–227.—An estimated 10,000 migrants of at least 39 species, arriving at the Gulf coast and meeting a cold front, were killed by collision with poles and other objects in a brightly lighted area.—J. T. T.

LLOYD, H. 1955. Mid-Atlantic migration of Long-tailed Jaegers and Terns (sp?). Canad. Field-Nat., **69**: 24.

SAUER, F., and E. SAUER. 1955. Zur Frage der nächtlichen Zugorientierung von Grasmücken. Revue Suisse De Zoologie, **62**: 250–259.—Blackcaps (*Sylvia atricapilla*) and Garden Warblers (*S. borin*) were tested for nocturnal migratory directional tendencies in a circular cage which screened off the environment below an angle of 68 degrees. Definite orientation was observed under clear or partly cloudy skies, even when the birds were raised from one day old in artificial light and arbitrarily selected day length. The birds showed positive phototropic response to the moon, bright meteorites, and directed artificial light. Complete disorientation occurred with full overcast, diffused light, and polarized light.—H. C. M.

ST. PAUL, U. v. 1953. Nachweis der Sonnenorientierung bei nächtlich ziehenden Vögeln. Behaviour, **6**: 1–7.—(From English summary.) Training in an experimental cage and with an artificial sun showed that typical night-migrants (*Sylvia nisoria* and *Lanius collurio*) have the ability to orientate by means of the sun.—F. M.

WHITAKER, B. 1955. Yellowthroat on Lundy: A new British Bird. British Birds, **48**: 145–147.—A specimen of *Geothlypis trichas* was trapped on Lundy Island, Devon, on 4 November 1954. In an editorial note it is stated that weather conditions were ideal for a drift passage between 31 October and 4 November. It is pointed out that passerine birds regularly migrate between Greenland and Europe, that assisted passages by ship would be admissible, and that suitable weather conditions immediately prior to discovery are no exact proof of drift migration.—M. T. M.

YAPP, W. B. 1956. Two physiological considerations in bird migration. Wilson Bull., **68**: 312–319.—Calculations based on various hypotheses indicate that different means of orientation in overseas flight have little selective (in the sense of natural selection) advantage over each other. Further calculations estimate the energy losses, the corresponding weight losses, of small birds in long migratory flights.—J. T. T.

PHYSIOLOGY

BEEKMAN, B. E. 1956. The effect of synthalin A on blood sugar and pancreatic alpha islet cells of the fowl. Endocrin., **59**: 708–712.

BRANT, J. W. A., and A. V. NALBANDOV. 1956. Role of sex hormones in albumen secretion by the oviduct of Chickens. Poultry Sci., **35**: 692–700.

COCK, A. G., and M. CLOUGH. 1956. Successful skin homographs in inbred chickens. Nature, **178**: 136–137.

HÖHN, E. O. 1956. Seasonal recrudescence of the thymus in adult birds. Canad. Journ. of Biochem. and Physiol., **34**: 90–101.—"The thymus of adult mallards and house sparrows of both sexes and of female robins shows a marked enlargement following the annual breeding season. In male robins the thymus begins to enlarge earlier, almost synchronously with the testes." The enlarged thymus becomes indistinguishable from that of immatures. The bursa Fabricii of adults does not enlarge. The distribution of thymus tissue in passerine birds and hawks differs from that in the chicken. Thymic enlargement out of season was not induced by castration or unilateral adrenalectomy in mallards.—F. M.

KRISS, J. P., F. S. GREENSPAN, W. H. CARNES, and W. LEW. 1956. Alterations in chick thyroid function induced by cobalt. Endocrin., **59**: 555–564.

LAKE, P. E., and D. G. M. WOOD-GUSH. 1956. Diurnal rhythms in semen yield and mating behaviour in the domestic cock. Nature, **178**: 853.—Volume of semen and number of spermatozoa greatest in late afternoon; mating highest when semen yields are at their best.—H. C. S.

NAKAJO, S., and K. TANAKA. 1956. Prolactin potency of the cephalic and the caudal lobe of the Anterior Pituitary in relation to broodiness in the Domestic Fowl. Poultry Sci., **35**: 990–994.

ROMANOFF, A. L., and H. LAUFER. 1956. The effect of injected thiourea on the development of some organs of the chick embryo. Endocrin., **59**: 611–619.—Thyroid hypertrophy, increase in weight of testes and adrenals, decrease in liver, and irregular decrease in ovarian weights.—H. C. S.

NOTES AND NEWS

It is with the greatest regret that we report the passing of three Fellows and former officers of the A.O.U. Josselyn Van Tyne, President of the A.O.U. from 1950 to 1953, died at Ann Arbor, Michigan, on January 30, 1957. John T. Zimmer, Editor of 'The Auk' from 1942 to 1948, died at White Plains, New York, January 7, 1957. Lawrence E. Hicks, Secretary of the A.O.U. from 1937 to 1946, died at Columbus, Ohio, January 20, 1957.

A new sales list of publications has been compiled by the New York State Museum and is available without charge on request to the Museum at Albany 1, New York. The revised list includes a considerable number of zoological bulletins, circulars, handbooks, etc., that were formerly considered out of print and have been available only through dealers. The stock of some of these items is small; in such cases, preference will be given to orders from libraries of universities, foundations, and other organizations.

William H. Drury, Jr., has been appointed to take charge of the education and research program of the Louise Ayer Hatheway School of Conservation Education which was recently established at Lincoln, Massachusetts, by the Massachusetts Audubon Society.

AOU COMMITTEES 1956–57

COMMITTEE ON BIOGRAPHY. A. W. Schorger, *Chairman*. Walter J. Breckenridge, Hildegarde Howard, J. Murray Spiers, Wendell Taber.

COMMITTEE ON BIRD PROTECTION. E. R. Kalmbach, *Chairman*. Jean Delacour, I. N. Gabrielson, Robert A. McCabe, David A. Munro.

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LOCAL COMMITTEE ON ARRANGEMENTS FOR THE SEVENTY-FIFTH STATED MEETING. M. Albert Linton and Philip A. Livingston, *Co-chairmen*.

STUDENT MEMBERSHIP AWARDS FOR 1957 SELECTED BY THE A.O.U. COMMITTEE ON STUDENT MEMBERSHIP AWARDS

Gene Doyle Amman, Colorado A. and M. College, Ft. Collins, Colorado
Robert Jack Badaracco, San Francisco State College, San Francisco, California
Gerald Joseph Bakus, Montana State University, Missoula
Harold Arthur Bantly, Harvard University, Cambridge, Massachusetts
Jackie David Batson, University of Tennessee, Knoxville
Joseph Vern Beckett, Kent State University, Kent, Ohio
George Bennett, Stillwater Cove Ranch School, Jenner, California
Delwyn Green Berrett, Brigham Young University, Provo, Utah
Arthur Charles Borror, Ohio State University, Columbus
Van A. Bradley, Niles Township High School, Lincolnwood, Illinois
Dilford Campbell Carter, Texas A. and M. College, College Station
Helen Virginia Carter, University of Wisconsin, Madison
Roger Barnum Clapp, Cornell University, Ithaca, New York
Dean G. Dillery, Ohio State University, Columbus
Robert J. Drake, University of Arizona, Tucson
Jay Newton Eisenhart, Cornell University, Ithaca, New York
David Earle Foster, Bowdoin College, Brunswick, Maine
Richard Cullen Funk, Colorado A. and M. College, Ft. Collins
William Gordon George, University of Arizona, Tucson
Jack Hensley, University of Arizona, Tucson
J. Alan Holman, University of Florida, Gainesville
Elden James, Walla Walla College, Walla Walla, Washington
Warren Jones, University of Washington, Seattle
Harvey Charles Kirk, Johns Hopkins University, Baltimore, Maryland
Peter Klopfer, Yale University, New Haven, Connecticut
Frederick Frank Knowlton, Cornell University, Ithaca, New York
Alice Lois McCollough, Judson College, Marion, Alabama
Leonard Jan Mook, McMaster University, Hamilton, Ontario, Canada
Temple A. Reynolds, University of Utah, Salt Lake City
John Salyer, San Diego State College, California
Sanford David Schemnitz, Oklahoma A. and M. College, Stillwater
Stella Marie Schmittner, Colorado College, Colorado Springs
Robert Wayne Schneider, Colorado A. and M. College, Ft. Collins
Ralph Walter Schreiber, Wooster High School, Wooster, Ohio

Lucy Jane Sharp, Southern Illinois University, Carbondale
Gerald Ray Smith, University of Utah, Salt Lake City
Thomas Kay Soulen, University of Wisconsin, Madison
Karl Stecher, Jr., Harvard University, Cambridge, Massachusetts
Stanley Melvin Teeple, Sydenham College, Ontario, Canada
Max Clyde Thompson, Southwestern College, Winfield, Kansas
Terry Alfred Vaughan, University of Kansas, Lawrence
George Elder Watson, Yale University, New Haven, Connecticut
Robert Barton Weedon, University of British Columbia, Vancouver, Canada
James Russell Werner, Phoenix College, Arizona
John Ogden Whitaker, Cornell University, Ithaca, New York
Lovett Edward Williams, Jr., Florida State University, Tallahassee
Robert G. Yoder, University of Arizona, Tucson

TREASURER'S REPORT FOR THE PERIOD OCTOBER 1, 1955—SEPTEMBER 30, 1956

Income to Active Fund Account

Dues		
Fellows	$ 306.00	
Elective Members	822.50	
Members	9,084.86	
		$10,213.36
Subscriptions		1,764.01
Sale of back issues of 'The Auk'		194.00
From authors for reprints		6.59
Royalty on microfilms of 'The Auk'		1.97
Miscellaneous sales		156.68
Advertising		267.50
Donations to Active Publication Fund		374.00
Committee on Arrangements, Boston Meeting, 1955		721.47
Income from		
General Endowment		2,825.76
Ruthven Deane Fund		479.67
Balance in Active Account, 1955		1,370.77
Total Income, 1956		$18,375.78

Special Funds

Brewster Memorial Fund		
Income from investments	$ 776.17	
Cost of 1955 medal		$ 283.03
Honorarium to Frank M. Chapman Fund per request of W. H. Phelps		493.14
	$ 776.17	$ 776.17
Educational Endowment Fund		
Income from investments	$ 143.11	
Debit for 1955		$ 27.31

24 Student Members, 1956		96.00
Postage		4.68
Balance in Account		15.12
	$ 143.11	$ 143.11
Bird Protection Endowment Fund		
Balance forward	$ 93.55	
Income from investments	98.49	
Donation to the International Union for the Protection of Nature		$ 25.00
Donation to the International Committee for Bird Preservation		25.00
Donation to the International Wildfowl Research Bureau		25.00
Balance in Account		117.04
	$ 192.04	$ 192.04
Special Publication Fund		
Balance forward	$ 276.29	
Income from investments	512.44	
Transferred to Investing Trustees for investment		$ 788.73
	$ 788.73	$ 788.73
Endowment Fund		
Balance in uninvested funds from 1955	$ 46.64	
Life Membership payments	1,517.00	
Donations	1,711.07	
To Investing Trustees		3,200.00
Balance in Account		74.71
	$3,274.71	$ 3,274.71
Research Book Fund		
Balance forward	$ 17.45	
Book sales	573.20	
Book purchase (Univ. of Illinois Press)		$ 462.48
Balance in Account		128.17
	$ 590.65	$ 590.65
Handbook of North American Birds Fund		
Balance forward	$4,320.33	
Donations	2,000.00	
Supplies and Equipment		$ 1,567.23
Balance in Account		4,753.10
	$6,320.33	$ 6,320.33
Marcia B. Tucker Fund		
Balance forward	$ 45.00	
Returned by 1955 Awardees	11.86	

Donation for 1956 Awards	500.00	
Judith Stenger		$ 250.00
Russell Mumford		200.00
Balance in Account		106.86
	$ 556.86	$ 556.86

DISBURSEMENTS

Manufacture and Distribution of 'The Auk'	$12,908.77
Reprints from 'The Auk' for the A.O.U.	44.57
Editor's Expenses	611.04
Secretary's Expenses	176.09
Treasurer's Expenses	992.05
Postage (back issues, research book, etc.)	159.72
Adding machine	149.04
Expenses, 1955 meeting	138.25
Expenses, 1956 meeting	329.96
Addressing service	383.17
Stationery, labels, etc	90.27
Telephone	6.35
Purchase and postage on back issues of 'The Auk'	9.60
Mailing of back issues of 'The Auk' (Intelligencer Printing Co.)	94.37
Bank charges and refunds	4.50
Cost of dues notices	217.32
Membership Committee expenses	9.50
Affiliation Fee, A.I.B.S.	100.00
Donation, Zoological Society of London	25.00
Donation, International Committee on Zoological Nomenclature	10.00
Membership Roster	1,162.87
Transfer of Auks from Patuxent, shelving and inventory	207.96
TOTAL EXPENDED, 1956	$17,830.40
Total Income, 1956	$18,375.78
Balance in Active Account, 1956	545.38
Balance in Endowment Fund	74.71
Balance in Educational Fund	15.12
Balance in Bird Protection Endowment Fund	117.04
Balance in Research Book Fund	128.17
Balance in Handbook Fund	4,753.10
Balance in Tucker Fund	106.86
	$5,740.38
Savings Account, First National Bank, Ithaca	$ 5,000.00
Interest, April-June, 1956	25.00
Checking Account, First National Bank, Ithaca, September 30, 1956	801.67
Total	$ 5,826.67

CHARLES G. SIBLEY, *Treasurer*

OBITUARIES

CLARENCE DUVALL BROWN, a member of the A.O.U. since 1937, died at Montclair, New Jersey, on June 29, 1956. He was born at Rutherford, New Jersey, on December 14, 1880, and joined the New York office staff of the Westinghouse Air Brake Company at the age of 17. He had been export manager of the company for many years when he retired in 1947 after 50 years of service. He served in the U. S. Army during World War I and attained the rank of captain.

Boyhood exploration of the Hackensack Meadows on hunting and fishing trips fixed a life-long interest in nature. Extensive travel for business reasons enabled him to obtain a rich background of field experience which he supplemented with the acquisition of an excellent library. About 1900 Brown collected specimens for the New York Zoological Society, his most notable find being a young Yellow-crowned Night Heron taken from a nest in the Hackensack Meadows, a breeding record not duplicated around New York City for over 35 years. His special interest in shore birds enabled him to contribute many notes to the late C. A. Urner's migration summaries of these species on the New Jersey coast.

He was among the first and most ardent students of hawk migration on Eastern ridges and still climbed to lookouts in the Kittatinny Mountains when well into his seventies.

"Brownie" served as president of the Montclair Bird Club, on the council of the Linnaean Society of New York, and was a founder of the Urner Ornithological Club of Newark and of the New Jersey Field Ornithologists' Club. Generous and self-effacing by nature, he preferred to contribute time and data to the projects of others, with the result that his only publications consisted of one article in 'Bird Lore' (1908) and papers and notes of a more local nature published by the Urner Club. Perhaps his most enduring contribution to natural science is the fine series of photographs appearing in 'The Ferns of New Jersey' by M. A. Chrysler and J. L. Edwards (Rutgers Press, 1947).—A. E. EYNON.

JOHN RUDY CRUTTENDEN, a member of the American Ornithologists' Union since 1940, died at Quincy, Illinois, on September 7, 1956. He was descended from an old family of Quincy where he was born on November 22, 1915. Following graduation from the Quincy High School, he attended the Gem City Business College and the University of Missouri.

He became interested at an early age in birds and their eggs, and in time became a highly competent oölogist. Accompanied by his wife, he made numerous collecting trips in the Far North, including five to Churchill, Manitoba. The last trip was to Arctic Alaska. The detailed data collected will be of great value to students of oölogy. An extensive correspondence was conducted with the leading oölogists of this country and Europe whereby he was able to obtain valuable sets by exchange. In 1952, he augmented his collection materially by purchasing the egg collection of the late Edward Arnold of Battle Creek, Michigan, and Montreal, Canada. The entire collection, representing 1185 species, is housed in a specially constructed museum on the family estate in Quincy, where it will be shown gladly to all interested people. Among the rare sets are those of Ross's Gull, Whooping Crane, American Knot, White-rumped Sandpiper, Sanderling, Eskimo Curlew, Passenger Pigeon, California Condor, Swallow-tailed Kite, Everglade Kite, Ivory-billed Woodpecker, Bachman's Warbler, and Connecticut Warbler. The raptors and shorebirds are unusually well represented.

As a final tribute to John, I wish to state that I have known him from boyhood.

During the past twelve years I have been with him on many collecting trips and found him to be very enthusiastic, whether he was collecting eggs of the Great Horned Owl when there was a foot of snow on the ground, climbing large elm or oak trees to the nests of the Eastern Red-tailed Hawk in the early spring, collecting eggs of the Double-crested Cormorant and Great Blue Heron among the old willow trees during highwater along the Illinois River, or dragging a grassy pasture in Missouri with a long rope to flush an Upland Plover from its nest, or digging to the nest of a Kingfisher from a high bank suspended by a rope, all are cherished memories. It was indeed a privilege and a pleasure to have known John as a friend, a scientist of remarkable personality and a lover of nature.—Byron W. Knoblock.

Ralph Emerson DeLury, a member of the American Ornithologists' Union since 1920, died in Port Perry, Ontario, September 20, 1956. Interment was in Prince Albert. He was born in Manilla, Ontario, November 23, 1881. Following attendance at the Port Perry High School, he entered the University of Toronto, receiving his B.A. in 1903, M.A. in 1904, and Ph.D. in 1907. He also studied at the University of Chicago and was an assistant in physical chemistry at Princeton from 1906 to 1907. Primarily an astronomer, he joined the Dominion Observatory as Observer in 1907, and on his retirement in 1946, he held the title of Acting Director.

He was long interested in ornithology and participated in securing spring migration records, taking the Christmas Census, and banding, from 1920 to 1945. At his residence, in 1926, he banded and measured more than 700 Redpolls. In his talks before the Ottawa Field-Naturalists' Club on such topics as "Photographing the Birds" (1938) and "Some Aspects of Bird Banding" (1939), as well as in his published articles, he used his own pictures, as he was an excellent photographer. His papers, "Sunspots and Living Things" (Trans. 17th. American Game Conference, 1930), and "Arrival of Birds in Relation to Sunspots" (Auk, 1923), show a happy blending of interest in two sciences. Among other papers may be mentioned: "The Experimental Farm as a Bird Sanctuary" (Can. Field-Naturalist, 1925), and an account of one of the first breeding records of the Evening Grosbeak in Ontario (*Ibid.*, 1922).

Among the many scientific societies to which he belonged, were: American Astronomical Society; Optical Society of America; Fellow of the Royal Society of Canada; Royal Astronomical Society of Canada (President, 1936–38); Fellow of the Royal Astronomical Society; Fellow of the London Chemical Society; Deutsche Astronomische Gesellschaft; Société Astronomique de France; American Society of Mammalogists; Cooper Ornithological Society; and Ottawa Field-Naturalists' Club (Second Vice-President, 1936 and 1937).—Hoyes Lloyd.

John Townsend Sharpless Hunn, a Life Member of the American Ornithologists' Union, elected in 1895, was born in Plainfield, New Jersey, on December 12, 1876. He continued to reside in the house of his birth until his death on October 2, 1954. In the 1880's this was a farm area, and he early developed an interest in the surrounding wildlife, especially the avifauna. About 1900, accompanying an ailing brother to the West, he discovered with delight the rich bird life of New Mexico, the seasonal movements of which were then little known, and made collections during two winters (1903–4 and 1904–5) in Silver City. He prepared his own skins with faultless care and these are still as well preserved as when they were made. In ensuing years, he traveled extensively in the West in connection with mining interests and always devoted every spare moment to its bird life. Important contributions of personal data were made to fellow ornithologists, especially on the

birds of Montana. In his native New Jersey he saw the rapid urbanization of farm and wilderness areas (including Dismal Swamp in South Plainfield, so well described by Negley Farson in 'The Way of a Transgressor') and noted in his journals such events as the appearance of the Starling (1912) and the attempts to introduce the European Goldfinch, which failed. In his later years, he regularly took part in the Audubon Christmas Count of the Raritan Estuary area which included both his home and a roost where, in a matter of minutes, scores of thousands of Starlings could be seen. In 1937 he helped to found the Urner Ornithological Club, of which he was an active member to the last. He was one of the three observers who first (1939) identified the Western Grebe in New Jersey, and in 1940 he added the Western Meadowlark to the state list. His publications were limited to the following notes in 'The Auk': 'Notes on Birds of Silver City, New Mexico' (1906); 'A Mockingbird at Plainfield, N. J.' (1930); and 'Western Meadowlark in New Jersey' (1941).—GILBERT CANT.

ROBERT WALCOTT, elected a member of the American Ornithologists' Union in 1924, was born in Cambridge, Massachusetts, October 17, 1874. He died on November 11, 1956. He was the son of Dr. Henry Pickering Walcott and the former Charlotte Elizabeth Richards. After attending the Browne and Nichols School, he graduated from Harvard *magna cum laude*. Following graduation he spent a year traveling in the Far East with his classmate Edward J. Holmes, subsequently the Director of the Boston Museum of Fine Arts. On his return, he entered the Harvard Law School, graduating in 1899. Although he lived in Cambridge and maintained a law office in Boston, he traveled extensively and was an adventurous explorer and mountain climber.

In 1906 he was appointed special justice of the Third District Court of Eastern Middlesex. His interest in the history and welfare of the community, the College, and the Commonwealth was expressed in many ways. A member of the Massachusetts Historical Society, he was president of the Cambridge Historical Society, the Cambridge Savings Bank, the Cambridge Hospital (later the Mount Auburn Hospital), the Cambridge Chamber of Commerce, the Harvard Chapter of Phi Beta Kappa, the Trustees of Public Reservations, the Colonial Society of Massachusetts, and, for thirty-one years, of the Massachusetts Audubon Society. He served on draft boards in the two world wars. In 1917 and 1918 he sat in the Constitutional Convention as, to quote his own words, "the one Republican of the three district delegates in a field of eleven candidates that included two Harvard professors. My grandfather sat in that of 1853, his father in that of 1833, and his grandfather in the Convention that accepted the Federal Constitution."

Judge Walcott's life was worthy of the standards set by his forebears. The bond between him and his father was exceptionally strong. Dr. Walcott was a widower when Robert entered Harvard; rather than live alone in his big house fronting the Cambridge Common, he asked the boy to stay there with him through the four undergraduate years. Although Robert missed a good deal of college life, he gained in other respects. Dr. Walcott, the most influential member of the Harvard Corporation, was a man learned in the natural sciences. He encouraged the boy's early interest in the study of birds that William Brewster, the first president of the Massachusetts Audubon Society, had awakened. While Judge Walcott was president of the Society, he contributed to its monthly *Bulletin* short pithy paragraphs notable for their variety of curious knowledge and acute observation.—ARTHUR S. PIER.

THE AMERICAN ORNITHOLOGISTS' UNION

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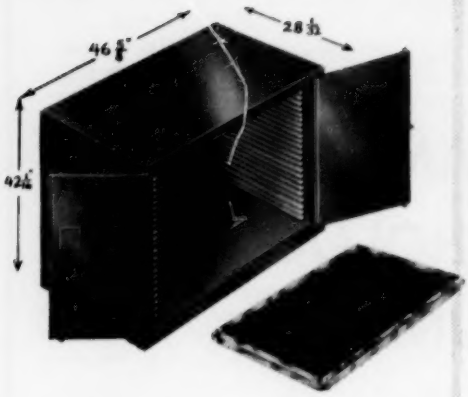

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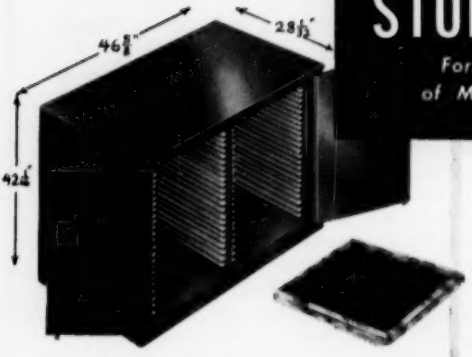

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